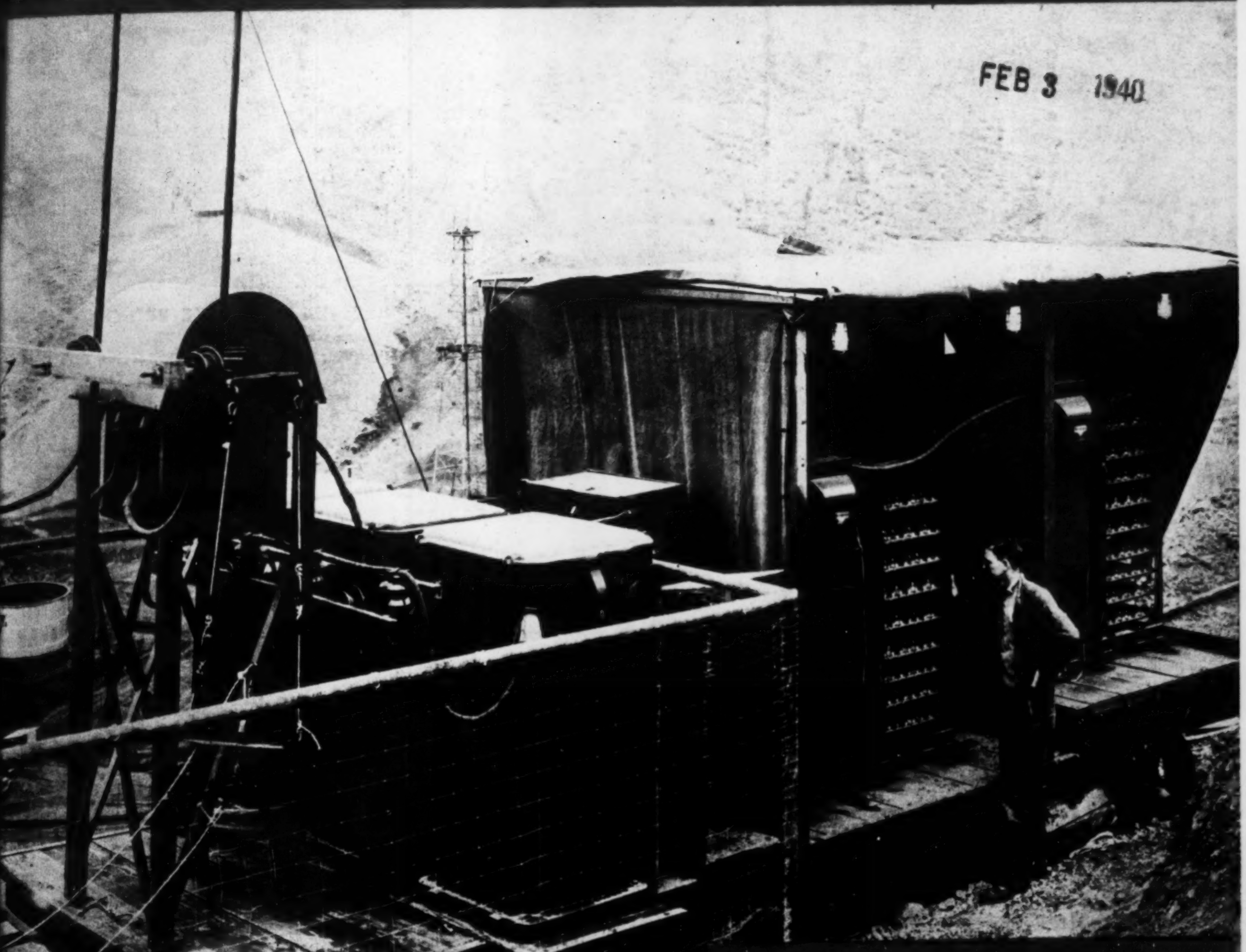
ENGINEERING CONSTRUCTION WEEKLY

ENGINEERING NEWS-RECORD

FEBRUARY 1, 1940

[illegible] supplying power to a construction job.



FEB 3 1940

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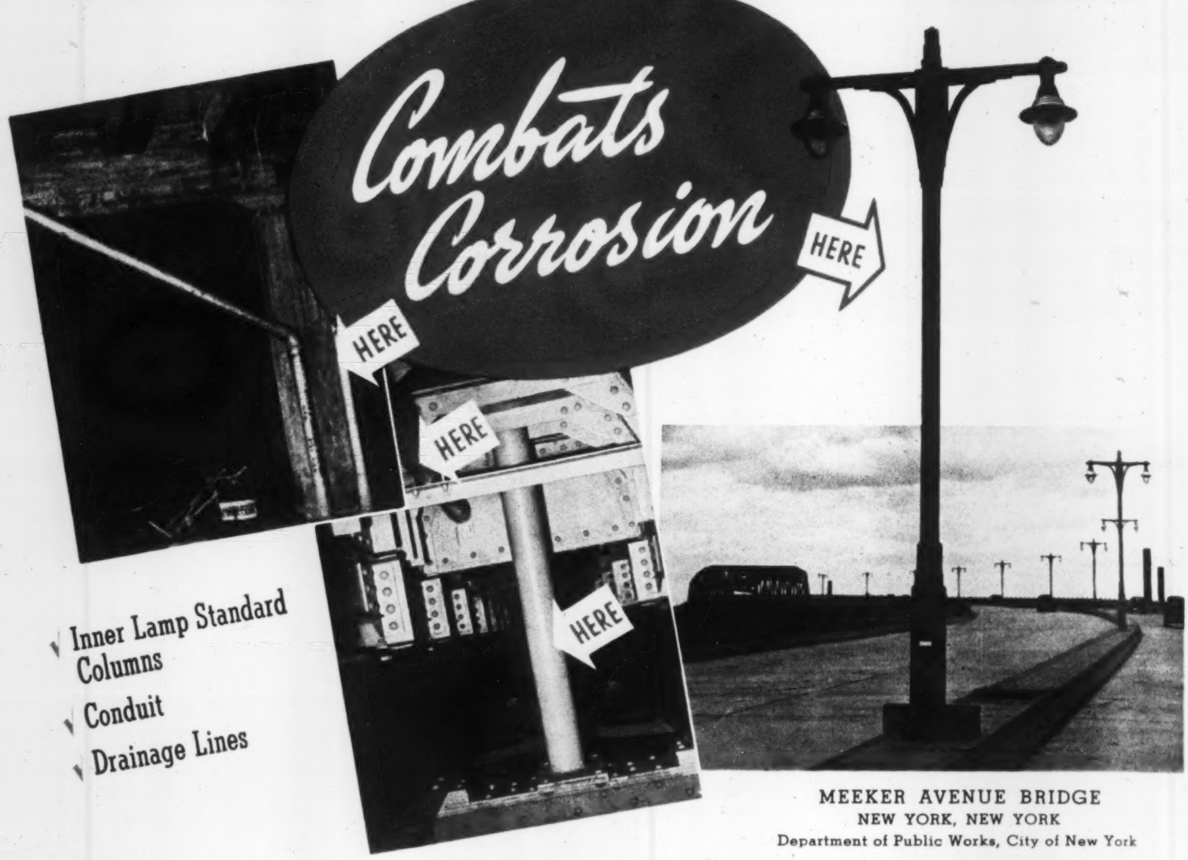
Electric Powered Construction Equipment

BYERS WROUGHT IRON



- Inner Lamp Standard Columns
- Conduit
- Drainage Lines

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NEW YORK, NEW YORK
Department of Public Works, City of New York

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ENGINEERING NEWS-RECORD

Devoted to Buildings, Sewers, Waterworks, Bridges, Highways, Streets, Dams, Foundations, Earthwork, Flood Control, Public Works, Irrigation, Canals, Railroads

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F. E. SCHMITT AND WALDO G. BOWMAN, *Editors* • ALBERT E. PAXTON, *Manager*

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THIS WEEK

- Many contractors look upon electrical equipment as designed chiefly to serve big jobs. Beginning in this issue is a series of articles by a mechanical engineer of wide experience telling how electricity and electrical equipment can serve the contractor on everyday jobs.

- Surprisingly clear evidence to show that certain combinations of cement and aggregates have an important effect on the expansion of concrete have been found in current studies of the California highway department. As resistance to excessive expansion is an important factor in determining its life, the California studies are important to all who use concrete.

- Waterworks men who have been asking questions about the new equipment developed for the ozonation of water will find most of the answers given in the article on p. 56. This is the first published account of the process, and the details of ozone application and cost were prepared by J. B. Klumpp, consulting engineer for the company that carried on the research leading to present installations.

- Rubber water stops for dams have been under study for some years past by the Bureau of Reclamation, and as a result extensive installations have been made. In this issue C. P. Vetter of the bureau gives a summary of the studies and illustrates the designs that have been developed to solve one of the major problems of dam builders.

THINGS TO COME

CURRENT PRACTICE in the design and construction of separating strips on divided highways will be the subject of an article in the Feb. 29 issue. It is the second in a series of divided highways.

CONTINUING the articles on electric power for ordinary construction jobs, an article to be published Feb. 29, will take up motors and motor control.

THE Annual Review Number will be published Feb. 15.

Underneath Chicago– *with* RYERSON REINFORCING

●

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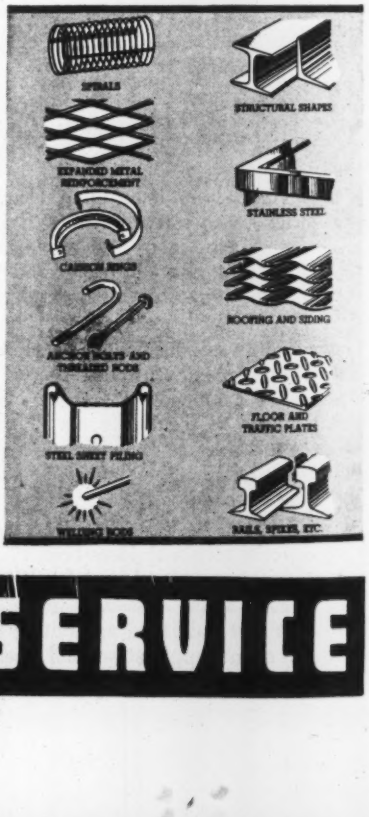
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ROOFING AND SIDING
ANCHOR BOLTS AND THREADED RODS
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RAILS, SPIKES, ETC.

RYERSON STEEL-SERVICE

NEWS
ENGINEERING NEWS-RECORD

Volume 124 FEBRUARY 1, 1940 Number 5

Washington Highway Set-up Condemned

Grand Jury charges that state legislature has surrendered control over highway department

A Thurston County grand jury at Olympia, Wash., last week, in a special report to a superior judge, severely criticized the system under which the Washington State Highway Department is operating. The jury has been investigating various state departments since last April, deriving authority from the fact that Olympia, Thurston County seat, is also the state capital.

The jury charged that the state legislature has surrendered its control over the highway department, with the result that there is no check on the expenditure of more than $50,000,000 biennium, and that the money is spent under a dual state auditing system which was branded as "obnoxious, disgraceful and ineffective."

Improper use of equipment

The report also made known that the principal complaints received about the department had been with respect to improper use of state equipment to improve private property or to convey privately owned materials. It also mentioned charges that employees had been paid for time off in excess of vacations,

(Continued on p. 34)

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Pennsylvania Towns Face Water Shortage

Central Pennsylvania towns depending upon river water supplies, especially on the Juniata and Susquehanna rivers, are facing a serious water shortage due to frozen streams and lack of rain, G. Albert Stewart, secretary of forests and waters, reported Jan. 29. Stewart has given permission to the municipality of Phillipsburg to erect a temporary dam on Moshannon Creek as insurance for sufficient water.

MYDDELTON CUP REPLICA GIVEN TO CIVIL ENGINEERS

Lord Lothian, British Ambassador to the United States, is shown presenting a replica of the famous Myddelton Cup to Donald Sawyer, president of the American Society of Civil Engineers. The presentation was made in Washington, D. C. recently, to the Am. Soc. C. E. by the Institution of Civil Engineers. The cup "a token of friendship and esteem" for the American group, was to have been presented at the British American Engineering Congress, planned for last September. Hugh Myddleton was a civil engineer on whom King James I conferred a baronetcy in 1622. Among his works were a London water supply, land reclamation on the Isle of Wight and a silver mine in County Cardigan.

Court Order Prevents Bridge Engineer Statue

A court order has been issued at San Francisco to keep directors of the Golden Gate Bridge and Highway District from spending $10,000 for a memorial to the late Joseph B. Strauss, bridge engineer who aided in the construction of the Golden Gate bridge.

The Taxpayers Defense League, Inc., which sought the injunction, asserts that the bridge directors in approving such a statue are acting beyond their jurisdiction.

I.C.C. Condemns Ohio-Erie Canal

Report to President states that canal would injure railroads of that area

The Interstate Commerce Commission in reporting to President Roosevelt asserts that construction of the $240,000,000 Lake Erie-Ohio River canal would weaken the railroads of that area so as to prevent them from meeting the "needs of the public for efficient and safe transportation." The report was asked for about a year ago when President Roosevelt was informed by the Board of Engineers for Rivers and Harbors that if the railroads would reduce their rates by an average of 29 cents a ton the project would not be

(Continued on p. 34)

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Washington Engineers To Study Welding

Interest in welding has been stimulated in Washington by the naval construction program, as a result the Washington Chapter of the American Welding Society has arranged a special educational lecture course extending over a period of eight weeks.

The lectures are to deal with welding processes; types of welded joints; welding as applied to building construction, bridges, rigid frames, floating equipment, derricks, cranes, and machinery. One lecture will deal with the qualifications of welders and the inspection of work.

Speakers will be Rear Admiral Ben Moreell, Chief of Bureau of Yards and Docks; Leon C. Bibber, welding engineer, Carnegie Illinois Steel Co.; C. H. Jennings, research engineer, Westinghouse Electric & Manufacturing Co.; A. N. Kugler, structural engineer, Air Reduction Sales Co.; Prof. C. D. Jensen, Lehigh University; George F. Wolfe, welding engineer, Dravo Corp.; R. W. Clark, research engineer, General Electric Co.

Illinois Engineers Discuss City Work

Resolution adopted favoring state registration of engineers and establishment of state civil service

Diverse major and minor aspects of engineering development, largely of a municipal nature, were covered at the annual meeting of the Illinois Society of Engineers, Jan. 25 to 27 at Rockford, Ill. Resolutions were adopted in favor of state registration of engineers and establishment of a state civil service system for engineers. Loran D. Gayton, city engineer of Chicago, was elected president for 1940, and B. C. McCurdy, county superintendent of highways at Belleville, Ill., vice president. For the best paper of 1939, the society's award was given to Sydney M. Wood, Waukegan, Ill., for his paper showing how the fluctuations of water level in the Victoria Nyanza suggested the influence of sun spots upon the varying levels of certain African lakes and the Great Lakes of North America.

Viscosity as a factor in the characteristics of flow of such materials as mud and sludge was discussed by Prof. H. E. Babbitt, University of Illinois, who pointed out that consideration of this factor is comparatively new in studies of flow of materials. The new $3,000,000 sewage treatment system of Rock Island, Ill., was described by D. W. Townsend, consulting engineer of Chicago.

Land drainage

Study of land drainage in relation to agricultural engineering, always a live subject at the Illinois meetings, included a paper by Jacob A. Harman, Peoria, Ill., on economic considerations of drainage of small agricultural areas by pumping. Prof. F. C. Bauer, University of Illinois, told of the enormous amounts of valuable crop-growing chemicals carried away by erosion and drainage waters, pointing out that the Mississippi River carries annually in solution some 36 million tons of such chemicals. R. S. Smith, of the State Agricultural Experiment Station, discussed the relation of drainage to the characteristics of Illinois soils.

Water softening

Water softening by a short-detention upward-flow process was described by H. A. Spafford, assistant sanitary engineer of the Illinois State Department of Public Health. The upward flow principle has been incorporated in 12 out of 15 plants built in Illinois in the past few years, it was pointed out.

Subdivision plotting was discussed by Adolph Vlk and G. A. Silander, both of Chicago. Silander told of a rectangular layout for 80-acre blocks ½-mile long, with residential frontages, inclosing a 20-acre space for schools and park—the arrangement permitting children to go to school without crossing any streets.

Public housing

Dean Rexford Newcomb, University of Illinois, in discussing housing stated that he considered it one of the most serious problems now facing the United States. Somewhat along the same line was a proposed modification of the state local improvement act by Amos Watts, the intent being to relax restrictions for the benefit of towns of less than 25,000 population. The act would permit the use of federal funds and motor-tax funds for street maintenance in such municipalities as well as for state highways and arterial highways. It would specifically authorize the employment of consulting engineers by towns and cities having no official city engineer.

Relation of the engineer to the public, with the duties and responsibilities on his side, and recognition of his special knowledge and capacities on the side of the public, was reviewed by Prof. E. W. Carlton, Missouri School of Mines. While the engineer is guardian of public health, safety, communication, housing and transportation, he is still rarely regarded by the public as a professional man, but rather as a skilled mechanic it was pointed out. Solution of the problem, it is believed, lies in ethics, publicity, standards, cooperation between the several branches of the profession, and education of the engineer himself as to his duties to himself, his profession and society.

• • •

Engineers to Inspect Johns-Manville Plant

A special trip including inspection of the Johns-Manville transit-pipe plant at Manville, N. J., has been arranged by the New Jersey section of the AWWA for Feb. 7. C. B. Tygart, secretary of the Association, Box 178, Newark, N. J., is in charge of arrangements.

BUILDING TO BE FINISHED IN TIME FOR 1940 CENSUS

Careful organization, good weather and the use of the vacuum process in the construction of concrete slabs are given credit for fast construction of Washington, D. C.'s new federal office building, which is to be put in use by the Bureau of Census Feb. 1. A floor construction scene is shown above.

Demolition and excavation for the $2,500,000 building began in August, but a series of strikes so delayed the work through September and a part of October that it was not until Nov. 11 that the first floor was poured. On Jan. 2, 52 days later, concrete was poured in the penthouse roof of the six-story structure. The building will be complete except for elevators in March. It is a reinforced concrete frame structure 320 by 360 ft. in plan, with columns every 19 ft.

Construction was carried on 24 hrs. a day. Forms were built and other skilled work was done by daylight, and concrete was poured at night. The picture gives an impression of the number of men used to make the job a fast one. Peak payroll was 1,500 men.

On the weather count, only 3½ days were lost. The vacuum process made it possible to use an integral finish on the floors, and to put equipment on the floors 12 hours after they had been poured.

McCloskey & Co., of Philadelphia, is the contractor, and Neal A. Melich is supervising engineer for the Public Buildings Administration.

BRIEF NEWS

DURING 1939, one of the busiest years the Montana State Highway Department has experienced since its organization, more than 1,040 miles of state roads were surfaced or resurfaced, 610 miles were graded or regraded, and 255 bridges and grade crossing structures were built. Don A. McKinnon, chief highway engineer, stated that the work cost $8,208,500.

AFTER SPENDING more than $17,000,000 for new sewers since 1906, the Louisville Commissioners of Sewerage is a body that is likely to pass out of the municipal picture this year, according to W. S. Caye, city technical engineer at Louisville. The commission is scheduled to cease functioning when its funds are expended, and only $400,000 remains to be spent under its supervision.

SPINNING of the main cables for the $6,000,000 suspension bridge across the Narrows at Tacoma, Wash., was begun Jan. 8 under the supervision of A. S. Halteman, resident engineer for the Bethlehem Steel Co., sub-contractors for the bridge superstructure.

BETWEEN July 1821 and Jan. 1, 1940, when the St. Johns River Bridge at Jacksonville, Fla., was taken over by the Florida State Highway Department and made toll-free, tolls amounted to $4,169,000. Operating expenses were $1,407,000.

A RESOLUTION proposing a state constitutional amendment which would prohibit diversion of road tax funds has been introduced in the House of Representatives in Kentucky.

FIRST TUNNEL HOLED THROUGH FOR PENNSYLVANIA TURNPIKE

A MOUNTAIN tunnel started in 1885 by the South Penn R.R. was holed through Jan. 22, marking the first tunnel completion on the $70,000,000 super highway between Pittsburgh and Harrisburg. Known as the Rays Hill tunnel the work was started by Mason & Hanger, New York contractors, 55 years ago and is now being completed by the same contractors as a $1,550,000 project for the Pennsylvania Turnpike Commission.

Totaling 3,393 ft. in length, the tunnel is the shortest of seven for the highway. When they held the original contract, Mason & Hanger drove 2,392 ft. of tunnel. This is now being widened and an additional 1,001 ft. driven to provide a passageway 28½ ft. wide and 25 ft. high, to allow one lane of traffic each way.

The commission expects that two or three tunnels will be holed through in February, a few more in March and April and the last one early in May.

Men in photo left to right are: C. E. May, resident engineer for the Turnpike Commission, Samuel W. Marshall, chief engineer, and Richard M. Merriman, chief tunnel engineer.

Road Show Opens With Huge Display

Exhibits costing $5,000,000 jam eight and one-half acres of floor space in Chicago

The 1940 Road Show of the American Road Builders Association, held in the International Amphitheatre at Chicago, opened Jan. 29 with the greatest display of construction equipment ever shown under roof. Three hundred exhibitors have jammed eight and one-half acres of floor area, 20 per cent more space than largest previous show, with machines, tools and supplies estimated to be worth $5,000,000. Early registrations and advance hotel reservations indicate a total registration of 40,000, far above the previous attendance record.

Equipment trends

Exhibits indicate trend of construction equipment development continues toward larger capacity units, faster and easier operation, rubber tire mountings, better design and materials, and diesel power. Most spectacular unit on the floor is 45-yard Le Tourneau Scraper operated by a big Tournapull Tractor, both being equipped with pneumatic tires 102 in. high and 30 in. in diameter. Several 2½ yard shovels are on display, larger than those usually shown. Dual drum pavers are receiving a great deal of attention. Bituminous road equipment displays exceed those of the past.

New highway legislation

The opening session of convention was addressed by Chairman Wilburn Cartright of the House roads committee. He discussed new highway legislation for the fiscal years 1942 and 1943, hearings on which now are underway. President Murray D. Van Wagner of the American Road Builders' Association reviewed progress of the association and appraised the job that is ahead. Henry F. Cabell, President of American Association of State Highway Officials, presented an unusually careful and sober analysis of current criticisms against increasing or even maintaining governmental expenditures at present levels, and showed how most of these criticisms are invalid so far as highway building is concerned. C. D. Curtis spoke for Thomas H. MacDonald, Commissioner of the Public Roads Administration, who was absent because of illness. Curtis reviewed trends and problems in highway financing.

Additional reports on the Road Show will be given in the February 8th and February 29th issues of ENR.

Washington Set-up

(Continued from p. 31)

and assertions that employees guilty of misconduct had been condoned by superiors. The jury was also critical of what it described as the department's failure to close out "job accounts" at the time the projects are actually completed.

Another complaint was, "Still further criticism is found in the treatment of the engineering charges to incorporated cities and towns for which the legislature each biennium appropriates 1½ per cent of the total allocations to such municipalities."

"After careful analysis of the department's general accounting practices," it was explained, "the jury is forced to the conclusion that most of the evils originate in lack of coordination between the engineering and auditing departments."

Engineering staff commended

The report was tempered by the statement that "the state of Washington has one of the finest highway systems in the world. Within the state lie some of the recognized outstanding engineering achievements in bridge and highway construction. The engineering staff of the department of highways, in the minds of bodies more competent to judge than this jury, has won nation-wide acclaim. The jury, therefore, while questioning costs and continuously demanding stronger safeguards to protect the highway dollar, commends the director of highways and his department for its many noteworthy achievements."

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Ohio-Erie Canal

(Continued from p. 31)

justified (*ENR*, Mar. 2, 1939, p. 257).

Among the conclusions of the report which was delivered to President Roosevelt four months ago but only made public last week, were:

(1) Permanent rate reductions of the type and magnitude specified would not be economically justified prior to construction of the canal, for the reason that on the information now available these reductions could not be confined to the traffic of those who would be expected immediately and directly to benefit by the construction of the proposed waterway.

(2) A large volume of traffic, at least 56,000,000 tons a year and probably more, would be affected in the event construction of the waterway is carried through and the gross revenue loss of the railroads would be about $35,000,000 a year and possibly more.

(3) The railroads can not afford to lose revenue in such an amount as the traffic in question produces or will produce.

(4) The railroads have ample line and terminal capacity to carry any traffic that is likely to develop for many years to come.

The canal would be a lock canal, toll free and tax exempt, to connect the Ohio River with Lake Erie via the Beaver, Mahoning and Grand River valleys to provide a minimum depth of 12 ft., a prevailing width of 250 ft. and a minimum width of 200 ft. The estimated potential traffic was 27,746,000 tons annually. Benefits were estimated to exceed expenses by about $8,000,000 per year.

• • •

Engineering Short Courses Planned at Rutgers

Rutgers University, in cooperation with the New Jersey State Department of Health, will hold two short courses for water and sewage works superintendents and operators. The first, which is sponsored by the New Jersey section of the American Water Works Association, will be held Feb. 5 to Feb. 17 and will deal with "Water Works and Filter Operation." "Sewage Disposal and Plant Operation" is scheduled for Feb. 19 to March 2. This course is sponsored by the New Jersey Sewage Works Association.

H. N. Lendall, professor of municipal and sanitary engineering, is in charge of these courses and will be assisted by Willem Rudolfs.

Small Reduction Seen For Federal Work

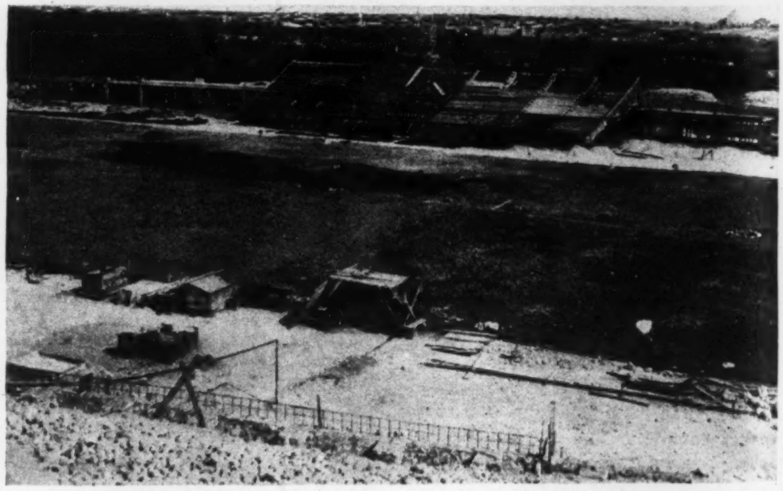
Actual expenditures may not be reduced more than $6,000,000 by proposed cuts

Although on paper the House last week cut about $17,000,000 for engineering and construction out of the budget recommendations of the Independent Offices Appropriation bill, these cuts are rather deceptive. Even though the Senate sustains the House's action, actual expenditures may not be reduced by more than about $6,000,000.

Public buildings cut

Biggest actual cut was a reduction of $4,720,000 in the budget figure of $25,220,000 for public buildings. This was achieved by dropping $1,000,000 for purchase of land in the District of Columbia for future use and deferring the start of work on four federal buildings in the district. Elimination of $1,000,000 budgeted for rebuilding on public lands will mean that none of this work will be done during the fiscal year 1940-41 except what can be paid for from carryover funds.

The $5,000,000 cut in the $30,000,000 recommendation for grade crossing elimination, however, has none but political significance. On Dec. 31, 1939, the Public Roads Administration alloted to the states the full $20,000,000 authorized for grade crossing elimina-



A HALF MILLION DOLLAR STADIUM FOR SAN ANTONIO

A stadium to seat 23,000 is being built at San Antonio, Tex., at a cost of $477,000. Known as Alamo Stadium, the structure is being built for the board of education on a 25-acre site.

The project is financed by $107,000 of school funds and a $370,000 WPA grant. Work is scheduled for completion in July. Phelps, Dewees & Simmons, San Antonio are the architects, H. A. Tolle acting as superintendent. W. E. Simpson & Co., San Antonio, represented on the job by W. E. Simpson, are the engineers.

tion during 1940-41 in the 1938 federal aid authorization act, and these allotments thereupon became contractual obligations of the federal government; the remaining $10,000,000 recommended in the budget is to cover allotments made a year previously. When the House fails to appropriate the money, it merely means the money will have to be provided in a defficiency bill next year—after election.

Housing cannot be cut

The same situation exists as regards the $5,000,000 cut which brought the appropriation for USHA subsidies down to $10,000,000. The U. S. Housing Authority, as authorized by Congress, has obligated itself to subsidize the local authorities. Since amounts of subsidy are not settled till the projects are nearly finished, it is impossible to tell how much will come due during the coming fiscal year. If USHA is right in its $15,000,000 estimate, Congress will have to appropriate another $5,000,000.

National planning different

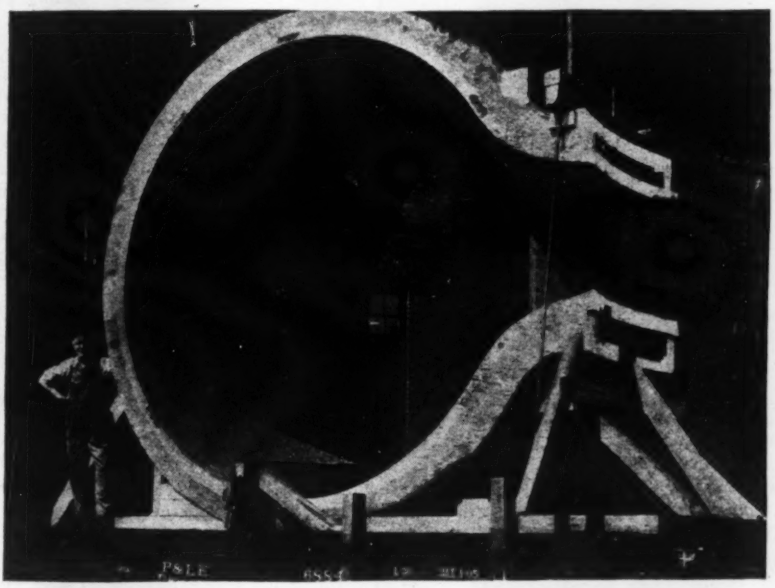
Elimination by the House of $1,060,000 budgeted for the National Resources Planning Board falls in a different category. NRPB was created by the President as part of the relief program and has always hitherto been financed from relief funds. This year, for the first time, its cost was put in the budget. The appropriation was therefore thrown out on the ground that Congress had never authorized the agency. A bill will doubtless be brought up later seeking to legalize NRPB, and action then will determine its fate.

One other cut that does draw a little blood is the elimination of $250,000 for the administrative expenses of the Federal Works Agency. This will mean that Administrator Carmody's office will have to draw on the funds of the subordinate agencies to meet operating expenses.

• • •

WPA to Aid Engineers In Obtaining New Work

John M. Carmody, administrator for the Public Works Administration, has instructed the Public Works Administration to make a determined effort to aid all engineers and other employees being added to the unemployed due to the large reduction of WPA rolls Feb. 1. He has suggested that regional directors compile a list of the personnel to be furloughed, listing each worker's experience and qualifications, these lists to be transmitted with appropriate letters of explanation to the principal industrial employers within the region.



HUGE CASTING STARTS LONG TRIP TO GRAND COULEE

THIS 400,000-lb. casting of medium carbon steel is shown loaded at Newport News, Va., ready for shipment to Grand Coulee Dam. It is about 15 ft. in diameter and 8 ft. wide at the widest point. The casting is one segment of a 200,000-lb. scroll case, which is being built for one of the 150,000 hp. turbines to be installed below the dam. The turbines will operate under a maximum head of 350 ft.

The casting was made by Newport News Shipbuilding and Dry Dock Co., Newport News, from plans prepared by the company's hydraulic department. The company holds a one and a half million dollar contract with the Bureau of Reclamation for three turbines.

Arizona Engineers Study Salaries

State section of Am.Soc.C.E. to employ secretary to fight salary battle

The Arizona section of the American Society of Civil Engineers last week voted 30 to 3 to endorse the principle of a paid secretary to fight the engineers' salary battle. To allow the secretary any official connection with the Arizona section was refused as was a resolution sanctioning a paid secretary and giving him official status.

The night before the meeting a petition was presented to Vic H. Housholder, section president, signed by more than 100 engineers who pledged one per cent of their salaries to pay for a field secretary. The petitioners declared "There will be a paid secretary in the field Monday morning (Jan. 29), either under the endorsement of the professional engineers or the AFL."

James Girand, city engineer of Phoenix, at the meeting presented the comparison between the recommended salary schedules sponsored by the national society and the American Association of Engineers, and stated the schedule of the latter society to be clear and understandable as compared to "hazy indefiniteness" of the Am.Soc. C.E. schedule. Girand also compared the salaries now being paid to the Arizona State Highway Department Engineers with the A.A.E. schedule and stated that present salaries are now 15 to 25 per cent below the recommended schedules.

Raymond C. Hill, who represented the Arizona section when a protest against reduction of engineers' salaries was made to the Arizona State Highway Commission last August, stated that the attitude of the commission was open minded at the meeting and that the commission had agreed to be guided by any recommendations which the society might make.

• • •

First Shield Used In Chicago in 1903

The first tunnel shield in Chicago was that used in 1903 on construction of a sewer along 39th St., and not that of Healy Subway Construction Co. in driving the State St. Subway, as stated on page 67 of *ENR* for Jan. 18, 1940.

Delays and extra expense incident to the first shield's use were said to have caused financial failure of the contractor, Farley and Green.

Special Construction Appropriation Sought

President asks Congress to supply $18,250,000 for five big projects

The President this week asked Congress to appropriate $18,250,000 to permit five big construction projects to continue at full speed between now and July. An additional $6,000,000 was requested for the Central Valley Project, for which $10,000,000 has already been appropriated for expenditure this fiscal year. Grand Coulee, with $23,000,000 already appropriated would get an extra $8,000,000. Both these projects have been progressing so rapidly that they are exhausting the available funds and will have to slow up if the money is not appropriated.

Demand for additional power has led to a requested $1,000,000 increase in the $4,000,000 appropriation for Boulder Dam. Also asked is $1,017,000 for completion of the power development at Elephant Butte Dam.

Because the war makes it necessary to complete as soon as possible the improvements to San Diego Harbor, $2,000,000 is asked for this project. San Diego is an important center for naval operations; increasing of the deep water area has been going forward for the past two years at the rather leisurely rate of a half million a year.

Also requested is $233,500 for water and sanitary facilities at the Canal Zone.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

The U. S. Supreme Court Jan. 29 upheld constitutionality of a Detroit city ordinance restricting the establishment and use of trailer camps in the city, affirming a Michigan Supreme Court decision.

The President this week asked Congress to supply $7,500,000 or more to build 50 small hospitals in towns throughout the country. Making maximum use of WPA labor, the cost, he thinks could be held down to $150,000 or $200,000 for 100-bed hospitals. The structures would be built by the Public Health Service without any local contribution.

The Bureau of Reclamation has stopped payments to the Western Pipe and Steel Co. which is manufacturing and installing penstocks at Grand Coulee Dam on grounds of alleged fraud. It is claimed that the company submitted a number of X-ray photographs of the same welded joint, asserting that they were photographs of different joints.

The House this week passed a bill providing that on military works in the Canal Zone, all employees doing technical, skilled, clerical or supervisory work must be citizens of the United States. Pay of such employees may not be less than that of similar employees of the Panama Canal. A similar bill has been favorably reported by a Senate committee.

OBITUARY

Wilfred G. Geile, 45, professor of structural engineering at North Carolina State College, died Jan. 27 at Raleigh. He was stricken in his office in the civil engineering building a few hours before he was to have addressed the closing session of the annual Institute of Engineers held at the college Jan. 24-27. Geile joined the North Carolina State faculty in 1927.

Lloyd E. Greathouse, 47, deputy administrator of WPA activities in St. Louis and St. Louis County since 1937, died last month in St. Louis. Greathouse was connected with the Missouri State Highway Department before joining WPA.

Lewen F. Searle, 63, for the past eight years assistant engineer of the Catskill-Croton division of the New York City water supply system, died Jan. 23 at Kingston, N. Y. Searle, a graduate of Massachusetts Institute of Technology, for a time was connected with the New York Central R. R. In 1906 he joined the engineering staff of the Catskill water supply project.

Francis W. Harris, 59, city engineer of Renton, Wash., was killed Jan. 22 when inspecting a WPA project. Harris went to the Pacific Northwest in 1902 as a civil engineer for the Chicago, Milwaukee, St. Paul & Pacific R. R. He was made city engineer at Renton in 1930.

Arthur H. Markwart, 60, vice-president in charge of engineering for Pacific Gas & Electric Co., San Francisco, died Jan. 25. After graduating from the University of California in 1904, Markwart engaged in engineering work in the San Francisco Bay region and soon joined the firm of Hilihan & Galloway. While San Francisco was preparing for its previous world's fair he served as chief of construction for the Panama Pacific International Exposition. Later he became a partner in the firm of Galloway & Markwart to engage in consulting engineering until 1920 when he became director of engineering with Pacific Gas & Electric Co.

August K. Stengel, 78, former superintendent of street construction in Louisville, Ky., died Jan. 21 in that city. Stengel, who early in life entered the construction business by joining his father's firm, Irvin Stengel & Son Co., was also employed by the Kentucky State Highway Department for eight years.

E. A. Evans, 86, former manager of the Quebec Railway, Light & Power Co., died Jan. 22 at Quebec City. Evans began his career in Canada in 1884 on survey and construction work for several branch line railways now part of the Canadian National Ry. Later he was employed on the Quebec Bridge. He retired in 1938.

Gilbert H. Friend, 58, senior engineer with the U. S. Engineers, Pittsburgh district, died Jan. 25 in Dormont, Pa. Friend went to Pittsburgh in 1938 from the Zanesville, Ohio, district where he had been engaged in the construction of flood-control dams. Previous to joining the army engineers, Friend served as assistant chief engineer for the Western Maryland R. R.

George Hausmann, 57, engineer in charge of construction of the sanitary sewer system for Manila, Philippine Islands 21 years ago, died in Mentor, O., Jan. 24. Hausmann was with the Austin Engineering Co., Cleveland, when he retired last December because of illness. He served for a time as chief engineer for the Cleveland board of education. He was a graduate of the Case School of Applied Science, Cleveland.

John B. Winston, 77, retired pioneer builder of Los Angeles, died Jan. 24 in San Diego. Winston was first employed in the office of Winston & Dockweiler at Los Angeles. Later he built the La Union Railway from Salvador to Guatemala City.

Harry J. Phillips, village engineer of North Pelham, N. Y., died Jan. 30 at the age of 51. He was a graduate of the Case School of Applied Science, Cleveland.

Other recent deaths include: **Charles C. Boerke**, 85, former engineer with the city water department of Wausau, Wis., and since 1922 retired, Chicago, Ill.; **Allen P. Sharpe**, civil engineer with the Ontario department of highways, Port Arthur, Ont.; **Lee Evett**, 57, civil engineer for the Southern Pacific, Los Angeles; **Lars H. Jensen**, 78, member of the construction firm of Jensen Bros., Omaha; **Frederick W. Carlin**, 86, retired builder formerly associated with the P. J. Carlin Construction Co., Brooklyn, N. Y.; **Pryce R. Phillips**, veteran civil engineer of Barrington, N. S., Yarmouth, N. S.; **Emory O. Crain**, 58, superintendent of streets for several years at Du Quoin, Ill., St. Louis; **Charles Raby**, 48, president of Peter Raby Co., Inc., Oswego, N. Y.; **B. E. Brooks**, 42, president of Brooks-Calloway Co., Memphis, Tenn., Atlanta, Ga.

CONTRACTS AND CAPITAL

Engineering construction awards for the week, $62,942,000, are 92 per cent higher than a week ago, and are 6 per cent higher than in the corresponding 1939 week. Private awards make up 54 per cent of the volume, the first time since last October that they have exceeded public construction.

The 1940 total for the five-week period, $254,919,000, is 31 per cent lower than a year ago. Private construction, however, is 31 per cent higher than last year.

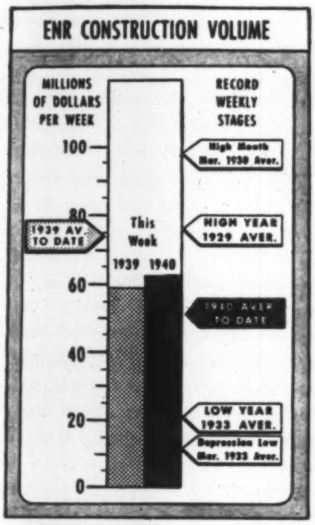
Private awards for the week are 271 per cent above last week and 86 per cent above last year. The increased industrial building volume is largely responsible for the gains. Public construction tops the preceding week by 23 per cent, but is 29 per cent lower than in the 1939 week.

A $15,000,000 copper smelting plant project in Arizona brings industrial building volume to its highest since June 24, 1937. In addition to industrial buildings, sewerage, bridges, commercial buildings, public buildings, earthwork and drainage, highways, and unclassified top their totals of a week ago; and bridges, commercial buildings, earthwork and drainage exceed their last year's totals.

New capital for construction purposes for the week totals $40,999,000, an increase of 302 per cent over the total for the corresponding 1939 week. This week's financing is made up of $37,916,000 in state and municipal bonds, $3,080,000 in corporate security issues, and $3,000 in RFC loans for public improvements.

New construction financing for the year to date, $114,907,000, is 44 per cent higher than in the initial five-week period last year.

(Weekly Table on page 29.)



Congress to Consider Housing Census

Information on housing facilities may be collected with decennial census

Within a few days Congress will make a final decision on whether information on housing facilities is to be collected in connection with the decennial census this Spring. The housing census was authorized last year, but no money was appropriated, and the money will have to be provided in the forthcoming deficiency bill.

The Census Bureau, although unable to spend any money, has formulated the questions to be asked and had sample forms printed. Thirty-one questions will elicit the structural type, equipment, and ownership of the 35,000,000 or so dwellings in the country. These questions will be asked by the same enumerators who take the regular census.

The census will determine what the exterior material is (wood, brick, stucco, other) and whether major repairs are needed; whether it is a one- two- or multi-family dwelling and whether detached or attached. The age will be asked and the original purpose of the structure.

The type of water, toilet, bathing, and lighting facilities will be asked, as well as the number of rooms and, if the dwelling is rented, the rental. Other questions will determine the number of occupants, the refrigeration, radio, and heating equipment, and the fuels used and their cost.

Finally, if the dwelling is owner occupied and mortgaged, nature of the mortgage will be determined.

The President this week asked Congress to appropriate $5,125,000 to finance the census of housing.

ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY ENGINEERING NEWS-RECORD, IN JANUARY, 1940

Engineering News-Record *reports projects of the following minimum costs: — water-works, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000

Four Weeks — Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Mid West	West of Mississippi	Far West	United States January 1940	United States January 1939	Canada
Public Works									
Waterworks	165	1,323	626	1,423	1,914	769	**6,220**	31,455	....
Sewerage	293	2,734	782	2,041	2,820	29	**8,699**	19,633	29
Bridges, public	454	3,035	810	1,176	921	1,609	**8,005**	25,489	80
Earthwork and waterways	85	2,992	559	166	5,837	5,000	**14,639**	21,158	91
Streets and roads	439	12,276	7,620	8,622	15,464	2,630	**47,051**	62,251	25
Buildings, public	895	13,659	10,043	3,463	5,756	4,678	**38,494**	88,401	276
Unclassified, public	311	2,364	2,069	1,694	1,746	3,403	**11,587**	12,015	150
Total public	**2,642**	**38,383**	**22,509**	**18,585**	**34,458**	**18,118**	**134,695**	**260,402**	**651**
Federal government (included in above classifications)	531	3,393	2,413	1,445	5,852	8,099	**21,733**	31,352	....
Private									
Bridges, private	....	....	....	....	....	....	....	856	....
Buildings, industrial	497	7,123	2,482	3,405	4,328	3,702	**21,537**	8,671	2,785
Buildings, commercial	2,194	10,045	2,790	3,438	3,516	601	**22,584**	30,601	575
Unclassified, private	90	6,535	3,315	1,288	1,868	65	**13,161**	11,163	100
Total private	**2,781**	**23,703**	**8,587**	**8,131**	**9,712**	**4,368**	**57,282**	**51,291**	**3,460**
Total Engineering Construction									
January, 1940 (4 weeks)	**5,423**	**62,086**	**31,096**	**26,716**	**44,170**	**22,486**	**191,977**	....	**4,111**
December, 1939 (4 weeks)	16,232	54,158	39,291	23,024	41,209	16,413	**190,327**	....	5,702
January, 1939 (4 weeks)	23,510	103,253	34,733	50,700	58,826	40,671	....	**311,693**	3,869

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Scrambled Words

Sir: The writer's attention has just been called to the wording of the first paragraph under the heading "Pipe Laying" in the writer's article entitled "Difficult Underwater Pipe Laying" which was published in *ENR*, Dec. 7, 1939, p. 746. The sixth line of this paragraph is printed twice and the third sentence is scrambled so that it does not make sense. The sentence should read "Then the cast iron follower ring, the cast iron split ring and the rubber gasket for the Usiflex joint were installed on the barrel of the pipe back of the spigot ball."

E. B. Myott
Fay, Spofford & Thorndike
Consulting Engineers, Boston

The Three-Point Problem

Sir: Referring to the article "The Three-Point Problem Simplified" (*ENR*, Oct. 12, p. 488), it appears to me that the authors have made an extravagant claim, that error of more or less consequence may be made by those who use it.

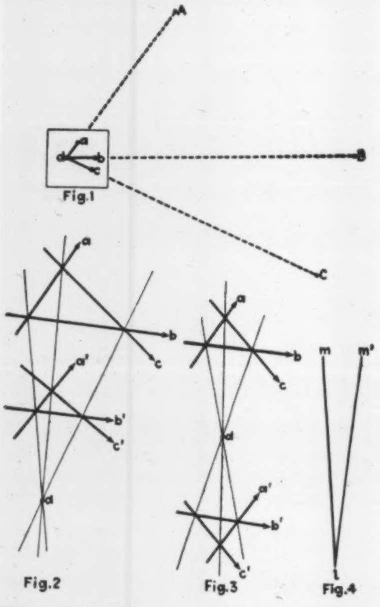


Fig.1 Fig.2 Fig.3 Fig.4

Figs. 1-4. Drawings showing location of plane table with respect to the three points, and the possible constructions that can be used to find the point desired.

The authors have presented a graphical field method which has undoubted advantage for certain procedures—most particularly for mapping small areas where it is more convenient to dispatch a rodman to each of the three points than to erect signals. For larger areas, it may expedite the convergence of approximations.

However, the authors claim the method is exact; blind acceptance of that claim may lead surveyors to appreciable error. This error is introduced by "joining the corresponding vertices of the two similar triangles with three straight lines." See Figs. 2 and 3. Instead of three straight lines, there should be drawn three arcs of circles, which will concur at the desired table station.

A full proof of this is not difficult, but it will be simpler to induce credence from the authors' drawings. Suppose the table were turned until points *a* and *b* (Fig. 1) were collinear with *A*; then the alidade-drawn vectors *a* and *b* would intersect at *b*. Similarly if the table were turned until *a, b* and *B* were collinear, with vectors intersecting at *a*. Hence the locus of all vertices determined by covectors from *A* and *B* must include points *a, b* and *d*. Only by coincidence could this be a straight line. It is essentially a circle—with negligible ellipticity because of eccentricities inherent in the plane table.

Now the circle *abd* may have so long a radius that a short arc can be taken as a straight line, or one of the two constructed triangles of error may fall near *d*; in these cases, the error may be negligible, but, these cases will be the exceptions.

A modified technique could avoid these possibilities of serious error. Two suggestions are offered. For one, if a third reference line *lm"* was added to Fig. 4 and three triangles of error were constructed by the authors' method instead of two, then each triad of corresponding vertices would determine a short circular arc and the three arcs would concur at *d*. A spiral celluloid curve could be used to draw the arcs accurately enough.

For the other, follow the authors' technique for construction of two triangles, then estimate the curvature by remembering that each of three curves must pass through two correlative signal points (map positions). A "good eye for curves" may be sufficient for setting a French curve, or a few long highway curves may be utilized for guides.

For either technique, it must be apparent that extrapolation, as in Fig. 2, is undesirable. Probably, also, if signals have been erected at the three points, it will be more expeditious to use the authors' technique as part of a method of successive approximations than to take time to draw arcs precisely.

R. Robinson Rowe
Assoc. Bridge Engineer
Dept. of Public Works
Sacramento, Calif.

Sir: Apropos the three point-fix, it might be said that "there's nothing new in the world," or so it might seem occasionally when one's ingenuity or curiosity has impelled him to work out a method or device, apparently new, for increasing the efficiency of his own efforts. The "triangle method" used in arriving at a *close approximation* by graphical means to the three point-fix, described by Jones and Basten (*ENR*, Oct. 12, 1939, p. 76-77) was attributed by Professor J. Maughs Brown, of the University of South Dakota, to Sergeant Cuncunnutti of the Mexican Army in the year 1592 (*ENR*, Jan. 10, 1935). While the method is not exact as claimed by Jones and Basten, and as pointed out by Hall (*ENR*, Nov. 9, 1939, p. 45), it does enable a surveyor to determine the second orientation of his plane table, usually within plottable limits of the true orientation after the second triangle of error is obtained. While it has not been published in some of the older manuals of topography, it has been known and used by some topographers in the Coast and Geodetic Survey for many years.

Most experienced plane table topographers who work on small scales where the three point-fix is a real advantage, and this includes most of the coastal topography by the Coast and Geodetic Survey as well as the plane table work of the Geological Survey, find little difficulty in determining a satisfactory orientation on the second attempt. Each individual may have his own method, but to one who has always had a special fondness for graphical methods, it has seemed a simple matter to visualize the arcs representing the loci of each angle of the triangle of error and its respective stations, and to sketch short sections of these arcs from the first triangle of error. When this has been done, an intelligent selection of the station to be sighted for the next orientation will usually make the second orientation exact within plottable limits. This method was pointed out by the writer in a note, p. 97, U. S. Coast and Geodetic Survey Field Engineers Bulletin, December, 1935.

PAUL A. SMITH
Hydrographic and Geodetic Engineer
U. S. Coast & Geodetic Survey
Washington, D. C.

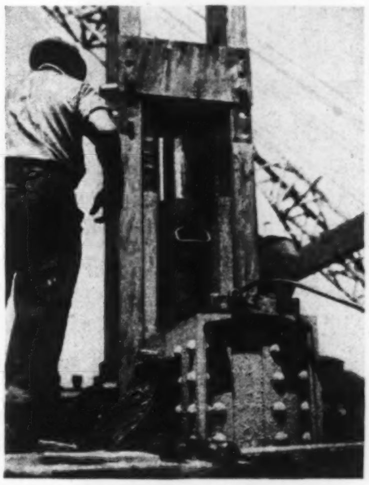
Lowering a 160-ton Load

Sir: Nathan Deutschman's excellent description of the cofferdam construction on the main piers of the Meeker Avenue Bridge in your issue of Nov. 23, p. 66, covered one feature of special interest to engineers and contractors engaged in this class of work, viz., the lowering of a prefabricated bracing form 46x 128 ft. in size and weighing approximately 160 tons, from four points of support.

The lowering of cofferdam bracing, as well as caissons, after fabrication is not new in construction procedure, but such methods have occasionally involved serious hazards to safety and several disastrous failures of supports have occurred. The contractor on the Meeker Avenue river piers first proposed to suspend and lower the bracing frame from *16 points of support.* His design contemplated the lowering of the frame by means of blocks and tackles and was predicated on a uniform distribution of weight during the lowering operation.

The writer's firm, foundation consultants on the entire project and designers of the main pier foundations, advised against the contractor's proposed arrangement because of the difficulty and even impossibility of uniformly lowering the frame from so many hangers and the probability that individual supports would be seriously overloaded. The design for the cofferdam bracing contemplated lowering the frame with a minimum number of supports. The bracing was sufficiently flexible vertically so that with four supports, as finally adopted, reasonable differences of level at the supporting points would cause no excessive stresses in the supports or the bracing itself.

The accompanying photograph shows the detail of the lowering arrangement at one of the supports. The four supports were each equipped with a 60-ton hydraulic jack, controlled from a central pressure pump so that all jacks were extended or released at a fairly uniform rate. The photograph shows both top and bottom pins in place preliminary to removing the bottom pin, also the 1-in. shim plates inserted on each side of the jack as a precautionary measure should failure of the jack occur. These shims were progressively withdrawn as the frame was lowered.


A 60-ton jack helps to lower a prefabricated bracing frame. Note shims placed between the load and base as a precaution against jack failure.

WILLIAM H. MUESER
Moran, Proctor, Freeman & Mueser
New York, N. Y.

Rusted Reinforcement

Sir: In your Dec. 14 issue (p. 11) you report briefly what our most recent bond tests are reported to have shown. Once in print, even the briefest of inaccuracies will outrun, outsmart and outlive pack upon pack of corrections loosed on their trail. Nevertheless, such corrections are not, I trust, wholly futile and they do seem to constitute our only available postmortem recourse. We trust, therefore, that you will give reasonable prominence in an early issue to the following modified excerpt from the Synopsis which appeared on p. 2 of our mimeographed manuscript:

"The general conclusions reached are that the light layer of loose powdery red rust that first forms is of negligible importance and that firm rust is not detrimental to bond resistance and may actually increase it. Wiping rusted bars off with burlap had no important effect for the shorter exposures, the tendency in these tests being to decrease the bond somewhat for early or short rusting periods. Wiping with burlap increased the bond resistance appreciably where the rust had become deep, loose and flaky as it was for the bars which were exposed for eight months."

In other words, the evidence from these tests is quite in agreement with the previously reported reconnaissances by Withey and Abrams, and in the more recent tests at Lehigh University; that, on the whole, the effect of firm rust on the bond of steel with concrete is benign and that even after the rust occurs in multiple layers and is loose and flaky, a simple wiping off with burlap insures a bond resistance in excess of that developed by the unrusted bars.

It is possible that you were misled by the fact that the bond was noticeably reduced for the unburlapped bars which had the longer exposures. Only very lax inspection would, however, permit bars so visibly covered with loose flaky rust as were those at the longest exposures, to be used without some rust-removal treatment. In these tests the device of wiping off firmly with a piece of burlap was adopted and the results show that this simple inexpensive procedure removed the loose rust sufficiently, not only to restore the bond to that of the unrusted bar, but substantially to increase the resistance developed. Apparently there is no need or justification for the more elaborate and costly wire-brushing which has sometimes been required. Wire-brushing was not investigated in these tests, the desire being first to investigate the simplest alternative in sight before searching further.

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ELECTRIC POWER for construction equipment is simple to apply and offers in several particulars a service that cannot be obtained with any other form of power. These facts, that are brought out in detail in a series of articles beginning in this issue, deserve the careful attention of contractors. It is clearly shown that electric equipment is not complex or hard to manage or mysterious in any respect, but is remarkably simple and sturdy and is independent of specially skilled operatives. To make its application possible in a wide range of work, manufacturers have provided an astonishing selection of sizes and capacities for stationary, portable or truck-mounted service. For the ordinary run of construction operations this service is particularly extended. As shown by the article in this issue, the problem of getting the power to the small operation, commonly regarded as one of the most forbidding by contractors, is simple to solve with modern portable equipment.

Engineers and Industry

Commendable action has been initiated by the Federal Works Agency with a view to assisting both engineers and industry. The agency's Public Works Administration—PWA to you—is rapidly tapering off its activities preparatory to shutdown next July, and in the process is disbanding the competent engineering organization it built up under Henry M. Waite and his successors, Fleming, Hackett and Clark. The change presents an opportunity to industry for the men released, originally selected on the basis of experience and later trained by six years of planning and administering a broad range of construction operations, are equipped to render service of high quality in many kinds of private as well as public activity. To assist the seeker after such service as well as the men released, the Federal Works Agency has set up under its personnel manager a file and record sheet system by which men of specified qualifications can readily be selected. The plan is admirable and simple, requiring initially nothing more than a request for information to the PWA Washington headquarters or regional offices. It deserves to be put to practical use.

Durable Concrete

Crazing is one of the occasional troubles in concrete that have largely remained a mystery. Stanton's success in tracing the cause of a particularly bad case of this trouble—crazing so severe as often to produce early disintegration—clears up doubts arising from the fact that suspected aggregates and suspected cements would many times perform quite satisfactorily. Interaction of cement alkalis with certain sand constituents was found to be the source of the California trouble, and it is quite possible that similar obscure chemical reactions may be at fault in other cases. It appears that there is still room for learning much about concrete, and that the research laboratory will often need the skill of both chemist and engineer to bring out the truth. The case also suggests that until we can develop foolproof aggregates there will be continuing need for study of concrete materials if we are to have durable structures.

Group Effort

There is food for thought in Henry Taylor's comment on "Why So Few Famous Engineers" given elsewhere in this issue. Without doubt, Mr. Taylor puts his finger on one of the basic reasons why engineers as a class are not held in as high respect as they once were; today the average citizen is too sophisticated with respect to engineering to be impressed by much that engineers do. But there is another element of the present situation, to which Mr. Taylor also refers, that appears to be more significant in coming to an understanding of why so few engineers stand head and shoulders above the crowd. It is that today the engineering of all our big undertakings is more complex, and as a result of greater specialization it is the product of the combined genius of many engineers rather than the work of any one man. Take a great bridge, for example: one engineer may have the basic conception, but he calls in an expert on soil mechanics to determine the character of the supporting material, has an expert on foundation design the piers, consults with skilled contractors as to the best methods of pier construction, calls in experts on steel to design the superstructure, looks to the engineers of the steel contractors to develop the most efficient method of steel erection and finally calls on highway engineers to design the approaches. The finished structure is the work of no one engineer; it is the result of the cooperative effort of many.

Rough Waters Ahead

ALL WAS PEACE and harmony last week in Washington when the experts concluded preliminary conferences concerning the projected St. Lawrence Waterway treaty, according to the limited information given out to the press. Substantial agreement was reported on such controversial questions as the Chicago diversion and it was stated that the experts hope to have the draft of a treaty in the hands of our Senate soon. If approval of the treaty rested with the experts the reports of harmony might be considered significant, but approval must be obtained from legislators on both sides of the border. They must accept compromises with respect to controversial questions before the treaty is approved.

The subjects over which controversy may be expected to develop are these: (1) the economic justification for a deep-draft waterway along the St. Lawrence River; (2) distribution of the cost of the waterway; (3) reallocation of the water diverted at Niagara for power, to which is closely tied the diversion of water from Lake Michigan at Chicago and Ontario's proposed diversion of Arctic waters into Lake Superior. Another possible subject is the matter of power development in the International Rapids, which will only come into the discussion actively if the federal government attempts to lay claim to New York's share.

The matters of the economic justification for the waterway and the correct allocation of its cost are old subjects that need not be discussed here, but a proposal to reallocate the water diverted from the Niagara River for power, as is implied by the statement that the experts are agreed on how the Chicago diversion is to be covered in the treaty, raises new questions of wide interest.

When the Boundary Water Treaty of 1909 was written all reference to the Chicago diversion was kept out of the final draft because the Americans maintained that that was a purely domestic question. However, Canada was allowed to divert much more water for power from the Niagara River than was authorized on this side, and that inequality stands today despite the reduction of the Chicago diversion to 1,500 cfs. Equalizing the diversion at Niagara will materially cut down the amount that can be diverted for power in Ontario, hence the provincial government may oppose a treaty that upsets its favorable position at Niagara.

On this side of the border, Chicago and the Mississippi Valley states may be expected to object to a treaty that fixes the diversion from Lake Michigan at Chicago. Within recent weeks Chicago has asked the Supreme Court to authorize a temporary increase of its diversion from 1,500 to 5,000 cfs until its sewage treatment works are completed in 1941. That adds complication.

Finally, Ontario has begun the diversion of waters from the Hudson Bay watershed into Lake Superior to move pulpwood down to the mills. That diversion can be increased to large amounts. If Chicago's extractions are purely domestic problems how shall the additions made by Ontario be considered? Who will get the benefit of one and who will take the loss from the other at all power sites in the international sections?

Engineering and legal experts may have come to agreement on these controversial questions, but that does not bind the legislators. The proposed St. Lawrence Treaty has rough waters ahead.

Ozone Stages a Revival

IT IS NO IDLE PREDICTION that widespread interest in the use of ozone for water treatment will be manifested now that new equipment has become available for its generation and application. As described in this issue, much research work has been done quietly in the last decade. This is reported to have resulted in the perfection of a process which can be economically applied as a bacteriacide and also for taste and odor control in municipal water plants.

Ozone treatment is not new. As far back as 1906 experiments were made with it on the New York City supply, and in the period 1908-14 it was used at Ann Arbor, Mich. and then abandoned. Several other cities tried ozone treatment but with the exception of two installations it was abandoned in all cases, largely because of its cost which was reflective of high electric energy charges and inefficient ozone generating equipment. In France, on the other hand, it has won popularity.

At the present writing two water plants using the new American ozone equipment are under construction, hence some time must elapse before economic evaluation on a large scale basis can be made between ozone and other treatment processes. Present knowledge would indicate, however, that there is a field of usefulness for the ozone process.

Concrete for Pensacola Dam

M. G. Fuller
Materials Engineer, Holway and Neuffer, Engineers
Grand River Dam Authority

***Contents in Brief** — The contractor on the mile-long multiple-arch and gravity-section Pensacola Dam in Oklahoma is placing more than 2,000 cu.yd. daily from a central plant with truck haul and crane-and-bucket distribution. Several different mixes are required for various parts of the structure. This article tells of the preparation of four sizes of aggregates, the arrangement of the mixing plant to obtain flexibility, the dispatching of trucks to proper stations, and concrete placement and formwork.*

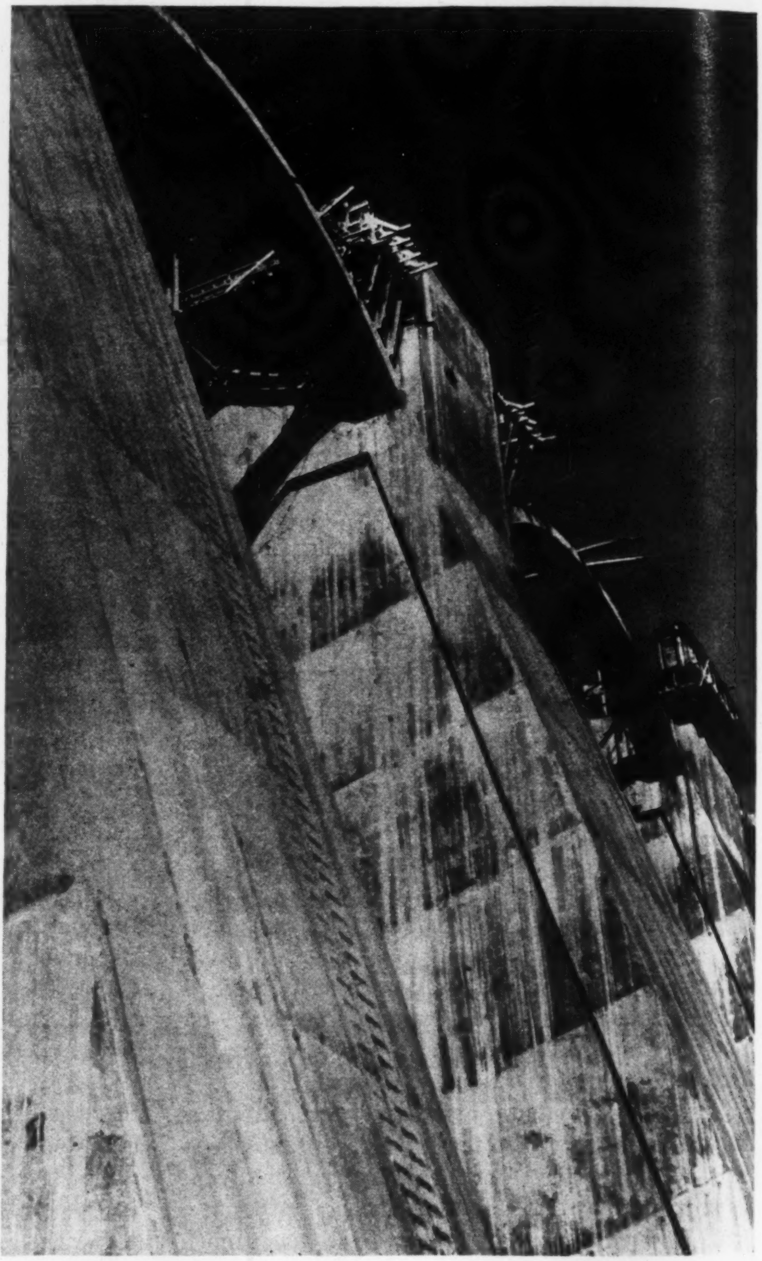


Fig. 1. Downstream face of thin-wall buttresses of Pensacola Dam. The slender arch ribs spanning between the units will carry a highway bridge.

PENSACOLA DAM, being built by the Grand River Dam Authority in northeastern Oklahoma, consists of 51 concrete arches, 140 ft. high in the riverbed, resting against hollow buttresses 84 ft. center to center; 870 ft. of gate-controlled overflow spillway gravity section; and 471 ft. of non-overflow gravity section, making up a structure that extends for more than a mile across the Grand River and its flat flood plain. A power house is being built in the river area, fed by steel penstocks through three of the arches. At the end of the year the dam was about 85 per cent complete. Concrete, supplied by a central mixing plant, has been placed in the various parts of the main dam at an average rate of 2,250 cu. yd. per day. An auxiliary plant furnishes concrete for two small spillway dams in saddles to the east of the main structure. The Grand River project was described in *ENR*, Feb. 16, 1939, p. 222.

The concreting plant and procedure are interesting. In order to maintain the required rate of progress, the contractor must place concrete in several locations simultaneously; and because different mixes are specified for various parts of the structure, maximum flexibility, as well as accuracy, has to be maintained in batching, mixing, dispatching, and delivery of the concrete.

Much of the dam consists of multiple arches—thin sections supported on thin-wall hollow buttresses. This design requires a large amount of

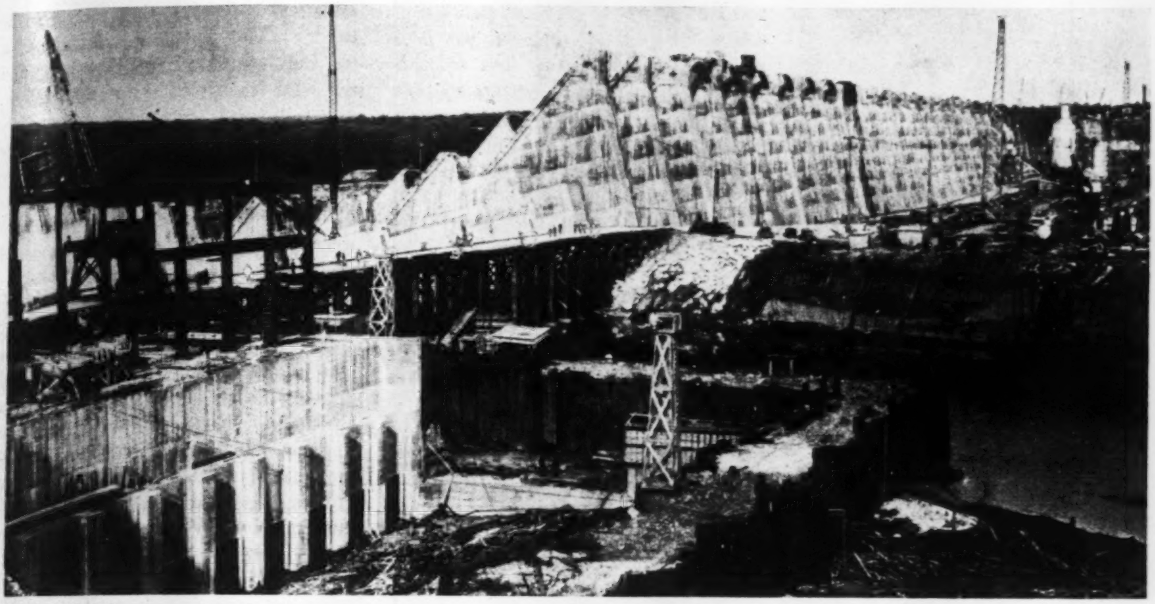


Fig. 2. Pensacola Dam extends for a mile across the Grand River flats. To the left is the power house being built within a cofferdam in the river section. Beyond, the multiple-arch and hollow-buttress section of the dam rises above the low bench.

formwork and complicates the concreting procedure. The arches, of 60-ft. span each, are on a slope of 9 horizontal to 10 vertical along the spring line. They are built to an inside radius of 31.83 ft. at the center, 25.22 ft. at the spring line. From the top to a point 60 ft. below vertically, the arch barrel is 2 ft. 4 in. thick; below this point it increases in thickness at the rate of 3 in. per 10 ft. of vertical height, making the bottom of the barrel 4 ft. 4 in. thick.

The arches are supported by the hollow buttresses. The upstream water slab of each buttress is 24 ft. wide. These water slabs vary uniformly in thickness from 2 ft. 2 in. at the top to 4 ft. 6 in. at the bottom. The sides of the buttresses, which carry the arch thrust, also vary in thickness from 2 ft. at the top to 4 ft. 6 in. at the bottom. The downstream face of the buttresses, on a batter of 1:4, are closed in by 18-in. face slabs. Inside each buttress four crosswalls, each 18 in. thick, placed 28 ft. apart and parallel to the front wall, act as stiffeners. These walls, carried from foundation level, stop short of the backwall (Fig. 3).

The spillway of the main dam is an ogee gravity section 870 ft. long, with spillway lip at El. 730 (full reservoir level is El. 755, top of non-overflow section, El. 757). Surmounting the spillway are 21 Tainter gates, each 36 ft. long, mounted between piers 5 ft. wide. These gates will control the top 25 ft. of reservoir. At the eastern end of the main dam is a non-overflow gravity section 471 ft. long. A bridge carries a 20-ft. roadway and 5½-ft. walk the full length of the dam.

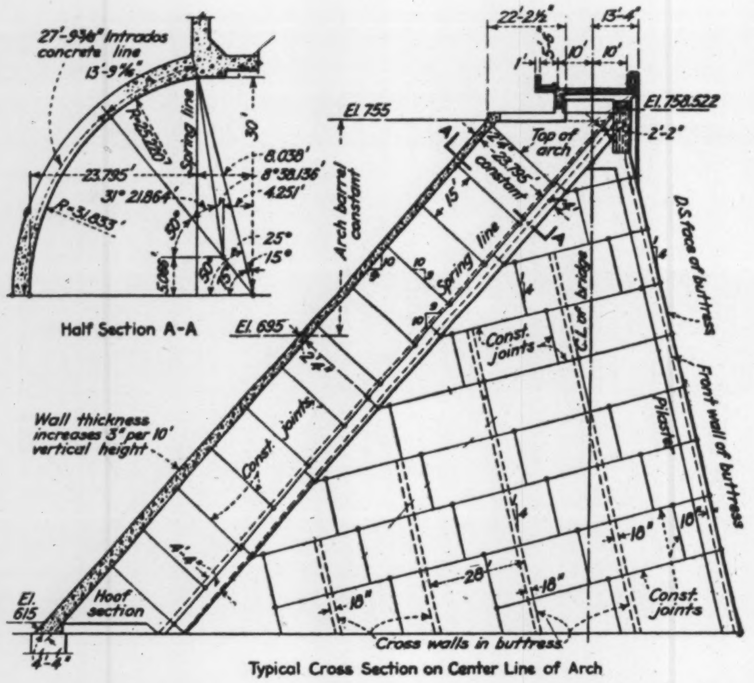
Crane and bucket placement

Because of the different mixes specified for various parts of the project, and the relatively small pours possible in the thin-wall arch and buttress sections, a highly flexible and mobile concrete placement system was necessary. The contractor decided that a series of high-frame gantry whirley cranes, working with a fleet of crawler cranes, and bucket delivery of concrete to the forms would meet the situation. Wide-gage gantry tracks were placed along the downstream side of the dam. In the multiple-arch area are three whirleys with 125-ft. booms, two 100-ft. boom whirleys are on the gravity section at the east end, and two more are on the powerhouse and river section of the dam. In the arch area one rail of the gantry track is at foundation level; the other is high on the road graded at the original ground level. One of the powerhouse cranes is inside the cofferdam, the other operates from a construction trestle.

However, even this array of whirley cranes is not able to handle all of the concrete. First, because the booms cannot reach the lower parts of the upstream portions of buttresses and arches; and second, because of the large amount of formwork a greater number of locations for simultaneous placing of concrete was necessary. Therefore, the placement scheme included a fleet of six long-boom crawler cranes for placing the foundations and lower sections of arches and buttresses. These cranes usually work under the arch, between the buttresses.

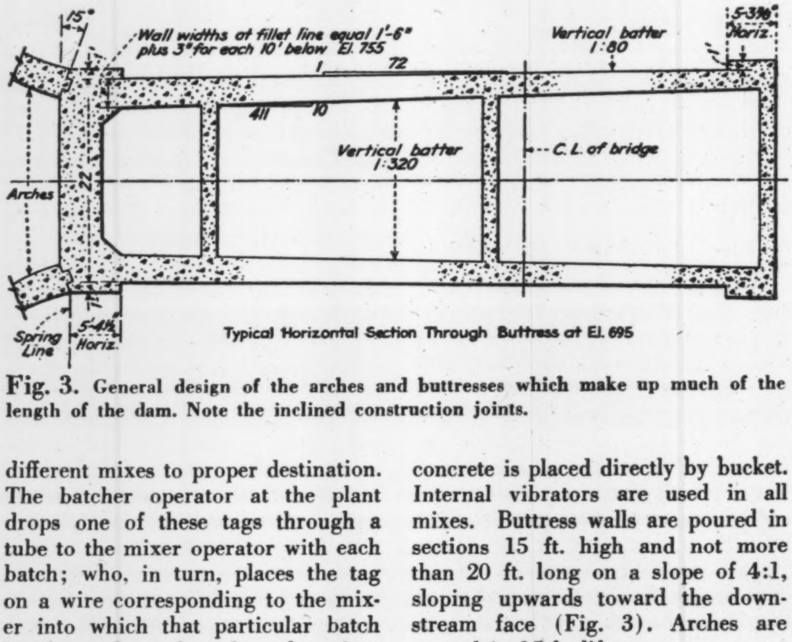
Concrete is delivered to the cranes, and thence to forms, in 2-yd. dump buckets, hauled one at a time by fast, light trucks, from the central mixing plant, located about mid-point of the dam on the downstream side. Each truck body has a capacity of two buckets. A single bucket is set toward the front of the truck when loaded at the mixing plant. When the truck arrives at the crane, an empty bucket from a preceding batch is placed on the rear of the truck, and the full bucket is lifted off. The truck returns immediately to the mixing plant, and backs into a bumping block which pushes the bucket forward on the truck ready for loading; at the same time the bucket is sprayed to keep it wet.

Metal identification tags, stamped with destinations such as "Buttress," "Arch," "Footing," "Powerhouse," and "Gravity" aid in dispatching the


27'-9 3/16" Intrados concrete line
13'-9 7/16"
R=25.220'
Spring line
30'
8.038'
8°38.136'
4.251'
23.795'
31° 21.864'
R=31.833'
25°
15°
50°
5.088'
El. 755
22'-2½"
13'-4"
1'
10'
10'
El. 758.522
2'-2"
Top of arch
23.795' constant
Arch barrel constant
15'
Spring line
C.L. of bridge
D.S. face of buttress
Const. joints
Front wall of buttress
Pilaster
El. 695
Wall thickness increases 3" per 10' vertical height
Const. joints
4'-4"
18"
28'
18"
Const. joints
El. 615
Hoof section
4'-4"
Cross walls in buttress

Half Section A-A

Typical Cross Section on Center Line of Arch


15°
Wall widths at fillet line equal 1'-6" plus 3" for each 10' below El. 755
Vertical batter 1:80
5-3 3/16" Horiz.
1
72
411
10
Vertical batter 1:320
C.L. of bridge
Arches
22
7
Spring Line
5-4½" Horiz.

Typical Horizontal Section Through Buttress at El. 695

Fig. 3. General design of the arches and buttresses which make up much of the length of the dam. Note the inclined construction joints.

different mixes to proper destination. The batcher operator at the plant drops one of these tags through a tube to the mixer operator with each batch; who, in turn, places the tag on a wire corresponding to the mixer into which that particular batch has been charged, and as the mixer is discharged, drops the tag through another tube to the truck driver. The driver proceeds to the destination designated by the tag. The tag travels with the bucket until returned to the plant, where it is redistributed. This system, although not perfect, is working far better than any other that has been tried to guide respective mixes to proper destinations.

On the arches and buttresses the buckets discharge into elephant trunk hoppers at top of forms; on the powerhouse and gravity sections the concrete is placed directly by bucket. Internal vibrators are used in all mixes. Buttress walls are poured in sections 15 ft. high and not more than 20 ft. long on a slope of 4:1, sloping upwards toward the downstream face (Fig. 3). Arches are poured in 15-ft. lifts.

Steel-lined wood forms are used in the variable lower monoliths of arches and buttresses. Steel forms are used for all other monoliths. Forms are handled by the cranes. On the upstream or water face of the buttresses and on the intrados of the arches the forms remain for 48 hr. after pouring; on all other faces forms are stripped in 12 hr. Curing of the underside of the arches is by a liquid curing compound; elsewhere it is by a constant water spray. Thin-section concrete must be at least five days old before another pour can be made. The buttresses are carried up well above adjacent arches, and no arch is carried more than 45 ft. above the arch sections on either side.

In gravity sections the concrete is poured in 5-ft. lifts. At least three days must elapse before pouring one block on top of another, and two weeks before another section can be poured against the side of a block.

Aggregates

The finding of suitable aggregates was a problem. There are no sand deposits in the Grand River Valley, and it was therefore necessary to go to the Arkansas River, 60 miles away, for sand. A well-rounded, suitably graded quartz sand was available in the Arkansas Valley, and the producers are able to meet the specification requirements by classifying and rejecting excessive amounts of middle sizes and adding from one to five per cent of fines, under 100-mesh, from adjacent aeolian deposits. Sand is shipped to the job in drop-bottom railroad cars.

The problem of coarse aggregate was not so easily solved. All possible sources within a radius of 25 miles were thoroughly explored by core drilling and test pits. All deposits of chert were eliminated, because this material did not stand up under freezing and thawing tests, leaving only limestone to be considered. One suitable deposit was finally located, about 40 acres in area and consisting of a crystalline limestone 22 ft. thick with a 6-ft. layer of hard blue sandy limestone on top. Durability tests showed both materials to be acceptable. Geologically this deposit is in the lower Mayes, and the quarry floor is the top of the Boone chert series.

The quarry is in the reservoir area. The contractor had to build one mile of railroad to the main line of the K.O.&G. R.R., then there is a 16-mile main line haul to Grand River Junction and a 5-mile run up to the dam. The contractor furnishes equipment and crews for this 22-mile haul of aggregate.

The quarry face was developed in two lifts by wagon drills. Rock is loaded by 1½-yd. shovels into the trucks for delivery to two gyratory primary crushers. From the crushers the rock is carried by belt conveyor to a screening plant where it is screened into four sizes: ¾ in., 1½ in., 3 in. and 6 in. The oversize material is returned to a secondary cone crusher, and the sized material goes to individual bins for delivery to 70-ton bottom-dump cars. This plant is now producing an average of 3,000 tons of crushed stone daily.

Aggregate storage

At the job the materials are placed in storage piles over a reclaiming tunnel. The cars dump into a special unloading hopper beneath the tracks, which discharges onto a belt conveyor feeding a shuttle conveyor which, in turn, stacks the various materials into stockpiles. The stockpiles have a capacity of 24,000 tons of rock and 6,000 tons of sand, of which 8,000 tons of stone and 2,000 tons of sand are live storage. A sprinkling system has been erected over the live storage piles to reduce dust as well as to place moisture in the stone and thus aid in cooling down the temperature of the concrete.

All aggregate, except the 6-in. stone, is fed onto a belt conveyor in the reclaiming tunnel through manually-operated gates. The 6-in. rock is dropped onto the belt by a mechanical feeder. The reclaiming tunnel is a 7 x 8-ft. timbered gallery running underneath the stockpiles for their full length, about 365 ft. The operator in the tunnel receives a signal as to which material is needed from the operator of the supply bins at the top of the mixing plant. The tunnel conveyor discharges onto the conveyor which elevates the material to the top of the mixing plant where it is dropped into the respective supply bins by a manually-operated chute. These bins have a capacity of 125 tons each for the sand and smaller stone and 60 tons for the 6-in. stone. This belt conveyor has a capacity of 360 tons per hour.

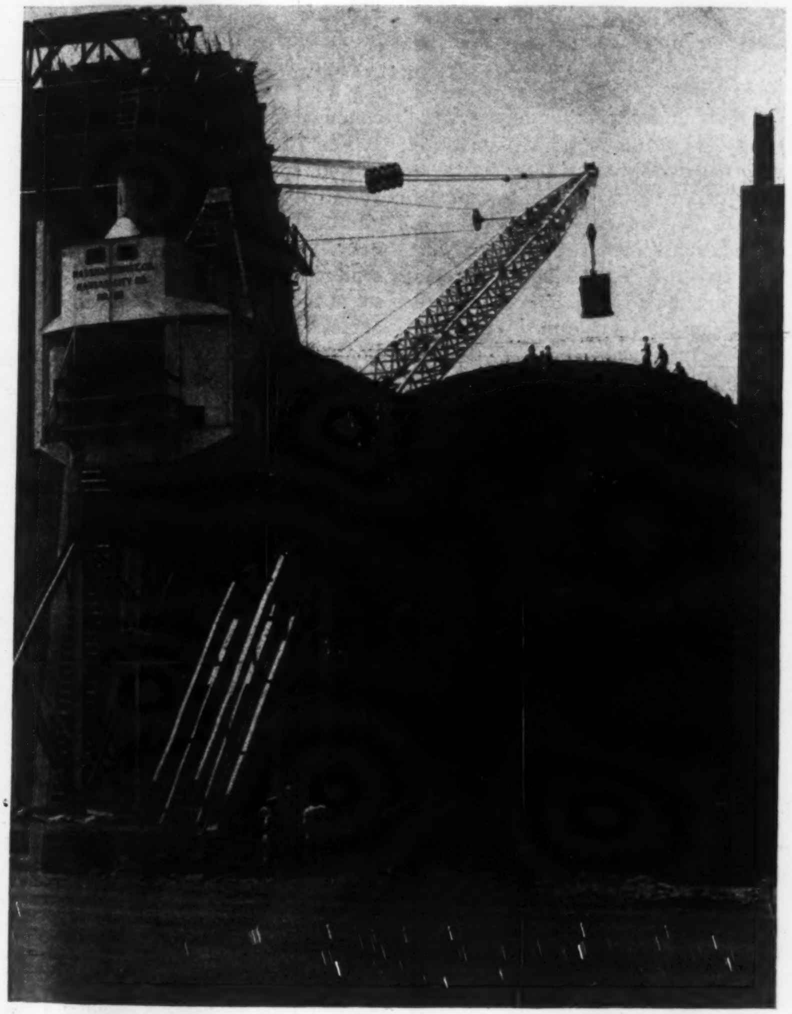
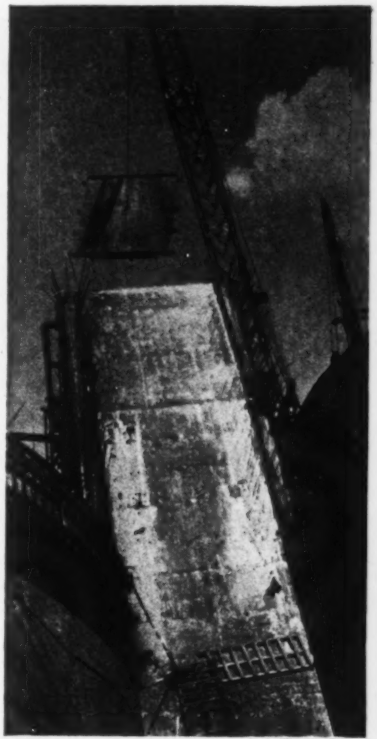


Fig. 4. Traveling high-frame gantry whirleys place all of the high concrete. Here is one of seven such rigs working on an arch section.



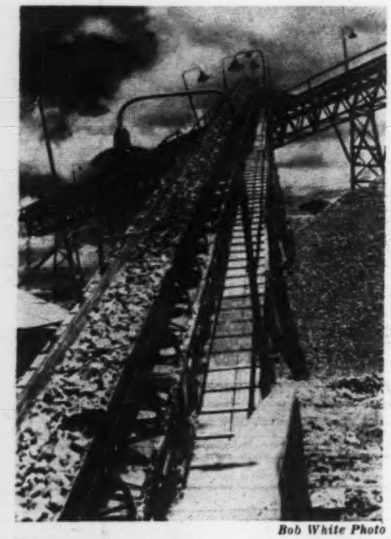
Bob White Photo

Fig. 5. Steel forms predominate for both arches and buttresses. This is a view of the water face of one buttress.

A modified bulk cement is used, which is shipped from four different plants. It is unloaded into a hopper and is transferred by screw-and-bucket conveyors either to the top of the mixing plant or to a 6,000-bbl. silo. Reclaiming from the silo is by a screw conveyor that carries the cement to the main bucket elevator. The capacity of the cement conveyor system is about 200 bbl. per hour.

Batching plant

The batching plant, directly below the storage bin in the mixing plant, contains weighing hoppers for four sizes of aggregates, sand, cement and water. All batchers, except for the 6-in. rock, have four scales, so arranged that four different mixes can be set at one time. The weighing is fully automatic. One operator handles all the weighing and batching equipment and, upon signal from the mixer operator, discharges the



Bob White Photo

Fig. 6. **After a long railroad haul concrete aggregates in four sizes are stored at the job over a reclaiming tunnel, distributed by the high belt conveyor in the distance, which is fed by the conveyor in the foreground.**

batch through a manually operated cathead into one of three 2-yd. mixers on the floor below. The mixer operator operates the cathead and the mixers, discharging them into the 2-yd. buckets carried by the trucks stationed directly underneath. Speaking tubes are provided in the plant so that the operators are able to converse with each other quite satisfactorily. Although the batching plant has been timed on numerous occasions at 150 cu. yd. per hour, the maximum 24-hr. operation to date is 2,765 cu. yd.

Direction

The project is being built by the Grand River Dam Authority, a state-created district consisting of fourteen counties in northeastern Oklahoma, empowered to issue revenue bonds for the development of hydroelectric power and for flood control. The work is financed by a loan and grant from PWA, and H. H. Ferguson is project engineer for the agency. Engineers for the authority in charge of design and construction are Holway and Neuffer of Tulsa, Okla. Chief designing engineer was Victor H. Cochrane of Tulsa. Massman Construction Co., Kansas City, Mo., has the general contract for the Pensacola Dam and power house; Robert G. Stowell is general superintendent.

Costs of a Welded Mill Building

***Contents in Brief**—A Pittsburgh all-welded mill building 155x207 ft. with runways for 15 and 20-ton cranes, showed a fabricating labor cost of 0.538c. per lb. and a total labor cost including erection of 1.176c. Comparable costs of a riveted structure are given as 0.646c. and 1.295c. The welded frame saved about 10 per cent in weight of material and 11.5 per cent in overall cost.*

FULL WELDED CONSTRUCTION was adopted for the structural steel frame of a new barge assembly shop of the Dravo Corp., Neville Island, Pittsburgh, on the score of expected savings in cost and time of construction. The actual costs realized are reported by Gilbert H. Atwood in a prize paper recently submitted to the James F. Lincoln Arc Welding Foundation. Compared with carefully analyzed cost figures for a riveted building, the figures show an overall saving of 11½ per cent in the cost of the framework by the use of welding.

The building consists of two longitudinal bays respectively 63 ft. and 91½ ft. wide by 207½ ft. long. The narrow bay has a clear height of 45 ft. to the bottom of the roof trusses and contains a 15-ton traveling crane; the wider bay is 36 ft. high and has a 20-ton crane. A 17-ft. lean-to adjoins one of the long sides. Both bays are covered by pitched-roof trusses, and the wider bay has a monitor for overhead lighting. One end of both bays is equipped with rolling doors that enable the full width of the bay to be opened at one time; the framing for these doors and other light steelwork such as ladders, walkways and sash frames is included in the weights and costs given.

The total weight of the steelwork is 520 tons. For all work excluding the doors and sash frames the shop fabrication labor cost averaged 0.538c. and the erection costs 0.598c. per lb. The sash and door items, about 5 per cent of the total weight, showed a fabricating and erecting labor cost of 2.180c. The total labor cost of the job was 1.176c. per lb. In addition, the welded work was charged with 7½ tons of welding rod.

Complete designs for an equivalent riveted building showed a total weight of 575 tons, or 10 per cent more than the weight of the welded building. Shop labor costs on the major material, estimated from careful analysis of shop operations, averaged 0.646 cents and erection 0.560 cents, making the labor cost for the entire frame erected 1.295 cents. Five tons of field rivets also had to be charged against the riveted design.

Main members of the welded building were made up as follows: Outer columns (20-ft. 9-in. spacing), 24-in. 100-lb. I-beam. Center columns (41-ft. 6-in. spacing), 24-in. 80-lb. I with 18-in. 42.7-lb. channel covers. Longitudinal trusses between center columns (41-ft. 6-in. span), chords and center post, 24-in. 80-lb. I with web set transverse, web members two angles from 4x3x$\frac{3}{8}$ in. to 7x4x$\frac{7}{16}$ in. Long roof trusses, top chord a split 24-in. 80-lb. I, bottom chord 2 angles 6x4x$\frac{3}{8}$ in., webs two angles 2½x2x¼ to 4x3x$\frac{5}{16}$ in. Short roof trusses, top chord 9-in. T 25 lb., bottom chord two angles 5x3½x$\frac{3}{8}$ in., web members one angle 2x2x¼ to two angles 3x2½x¼ in.

Erection seats and clips were fully provided, so that few holes for erection bolting were required. The purlins and girts were bolted to their clips. The corrugated roofing, however, was welded to the purlins while the siding was fastened to the girts by bolted clips.

Fabrication and erection were carried out by the company's own forces. For the costs prevailing at the time of construction (November, 1936, to February, 1937), and with an assumed 50 per cent charge for overhead and other costs, the costs of the two building frames were $40,594 for the welded structure and $45,288 for the riveted structure, an excess cost of 11.5 per cent for the riveted building.

Rubber Waterstops for Dams

C. P. Vetter
Engineer, U. S. Bureau of Reclamation,
Denver, Colo.

***Contents in Brief**—After several years' investigation, engineers of the U. S. Bureau of Reclamation, working with rubber manufacturers, have developed a novel rubber waterstop which now is in use in the Imperial Dam and structures of the All-American Canal. Details of the seals are given and results of tests as to their functioning under movement along joints in which they are inserted. A long life for rubber is expected under conditions to which waterstops are subjected.*

Rubber waterstops were used in the joints in Imperial Dam, recently completed by the U. S. Bureau of Reclamation, and in structures built on the All-American Canal. These waterstops are the result of extensive studies conducted by the bureau to develop the best form for such seals and to determine their probable life under conditions to which they will be subjected.

Whenever large engineering structures are founded on material which, under load, may be expected to compress or yield to a measurable extent, some articulated type of construction is essential to avoid excess stresses in the various parts of the structure due to unequal settlements. Under such circumstances it is desirable that provisions be made so that the individual sections or units of the structure may adjust themselves individually to the loads without the transfer of unknown and unpredictable loads to adjacent units. Settlement of a structure, while often looked upon as a weakness, is always inevitable and the exact magnitude, even with the aid of modern methods of soil mechanics, may be difficult to predict under given conditions of loading. Settlement does not necessarily mean that the structure is unsafe, provided proper precautions have been taken to permit the structure to settle without subjecting it to undue and indeterminable stresses. If the structure to be constructed on yielding ground is a hydraulic structure, the problem will arise of how a watertight seal between the individual sections or units may be provided.

In the case of Imperial Dam the major portion of the dam is of the floating type, founded on river sand and silt while the remainder, mainly consisting of piers supporting heavy gates, is supported on piles. Settlements of the magnitude of inches were expected of the floating part of the dam while settlements of the part supported on piles were anticipated to be quite small. (See *ENR*, Oct. 17, 1935, p. 538, for a general description of Imperial Dam.)

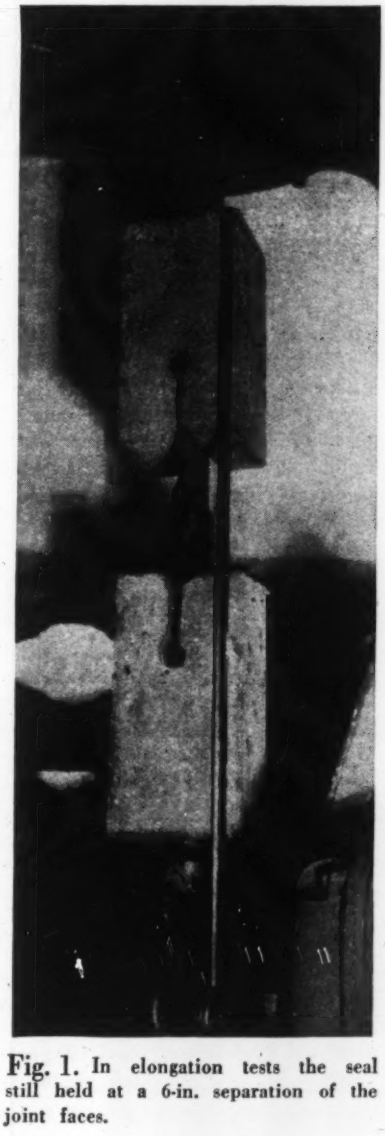


Fig. 1. In elongation tests the seal still held at a 6-in. separation of the joint faces.

To permit the individual sections to adjust themselves under the load without the transfer of part of the load from a section to the adjacent ones, waterstops between the sections were required which would readily deform and stretch according to the relative movement of neighboring sections and which, at the same time, would insure reasonable watertightness. The stainless steel or wrought-iron plates often used for such waterstops were not suitable in that they could not be relied upon to provide a watertight seal for the large relative movements anticipated.

Expected life of rubber seals

Investigations as to the life of rubber used in similar situations indicated that the earliest use as rubber seals was in the form of rubber gaskets in pipelines. A record of 61 years was obtained on a gas line in Elizabeth, N. J., where the gaskets removed in 1931 were still "in a fine state of preservation and their physical properties very high." Records of gas line gaskets in good condition after 24 years' service in Cincinnati and 41 years in Columbus were found. F. F. Longley, chief engineer, Lock Joint Pipe Co., reported European gaskets in good condition up to 65 years old. The narrow fins in the clearance space between joints were hardened and cracked and their elasticity was destroyed but the main body of the gasket was still elastic and in good condition. Exposure tests made by the Gates Rubber Co. in Denver over a period of more than 10 years have indicated that, while gum stocks left in the sunlight and exposed to the elements crack and deteriorate in a comparatively short time, it is possible to compound special stocks which, after long exposure, show remarkably little deterioration.

Accelerated tests

Various accelerated tests have been devised for the determination of the resistance of rubber to deterioration. Such tests are the Geer oven test in which vulcanized rubber is subjected to freely circulating air at 70 deg. C., and the Bierer-Davis bomb test, in oxygen at a pressure of 300 lb. per sq. in. at 70 deg. C., and the heat pressure test, in air at a pressure of 80–85 lb. per sq. in. at 126 deg. C. Although these accelerated tests may give valuable indications of a rubber compound's aging properties, they do not always give reliable information about the behavior of the compound under actual exposure conditions.

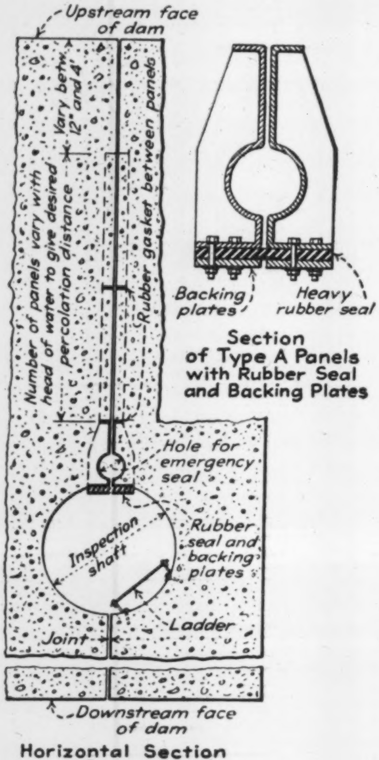

Upstream face of dam
Vary betw. 12" and 4'
Number of panels vary with head of water to give desired percolation distance
Rubber gasket between panels
Backing plates
Heavy rubber seal
Section of Type A Panels with Rubber Seal and Backing Plates
Hole for emergency seal
Rubber seal and backing plates
Inspection shaft
Ladder
Joint
Downstream face of dam
Horizontal Section thru Dam at Joint

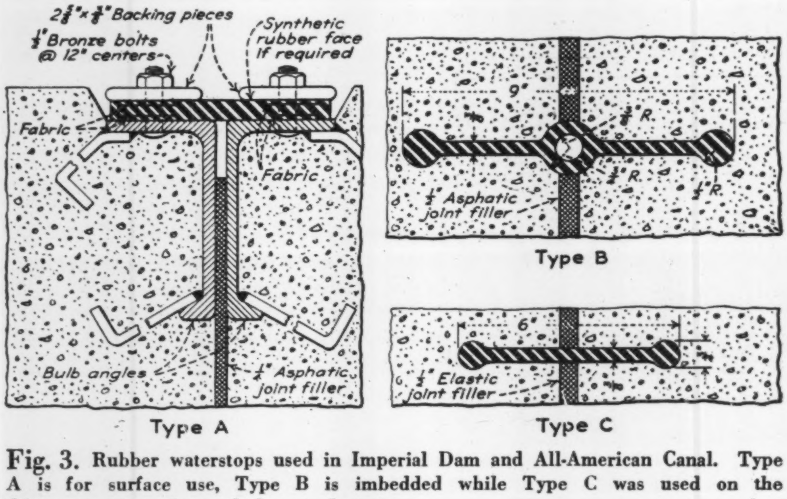
Fig. 2. A proposed rubber waterstop to be placed in an inspection shaft in high dams.

Recently, several synthetic rubber compounds have been brought on the market, such as Neoprene, Duprene and Thiokol. Laboratory tests and actual exposure tests have indicated that some of these compounds have aging properties superior to those of natural rubber.

The conclusions which may be drawn from these investigations are that, if properly compounded and protected from light and air, rubber will retain its life as here defined, over a long period of years.

Stops in Imperial Dam

For use in the various structures of the Imperial Dam and desilting works two types of waterstops were designed, Types A and B, as shown on Fig. 3. Type A is placed on the surface of the concrete so that the seal may be replaced if necessary at some future time. It consists of a 6x½-in. rubber strip, reinformed with two layers of fabric along each edge and fastened to bulb angles by means of bronze bolts and steel backing pieces. Where the rubber is exposed to air and light a strip $\frac{1}{16}$ in. thick of a synthetic rubber compound is vulcanized to the outer side of the seal. Type B is entirely embedded in concrete. The solid bulbs along the edges are intended to prevent the seal from being pulled out should the adjacent blocks move away from each other. The hollow bulb in the center is intended to prevent shearing of the rubber in case the adjacent blocks move laterally with respect to each other in a direction perpendicular to the face of the seal.


2⅝"x⅜" Backing pieces
½" Bronze bolts @ 12" centers
Synthetic rubber face if required
Fabric
Fabric
Bulb angles
½" Asphatic joint filler
9"
⅜" R.
¾" R.
½" R.
½" Asphatic joint filler
6"
⅓" Elastic joint filler

Type A

Type B

Type C

Fig. 3. Rubber waterstops used in Imperial Dam and All-American Canal. Type A is for surface use, Type B is imbedded while Type C was used on the thin concrete sections of the canal structures.

Type C, developed in connection with the design of structures along the All-American Canal, is for use in thin concrete structures where only small relative movements are anticipated.

Before it was used for construction the behavior of Type B was tested in the Bureau of Reclamation laboratory in Denver with results shown in Fig. 4.

Field splicing was confined to straight runs of the seal, and a special, electrically heated mold was used for the purpose.

At the present time all these types have been in use for two years with entirely satisfactory results. Actual relative displacements of 2 in. have been observed at Imperial Dam without noticeable leaks.

The following specifications were used for the purchase of the straight water-stops, the special connection pieces, the molds and the field splicing unit.

Material

The molded waterstops shall be made from a stock composed of a high-grade tread compound, made exclusively from new plantation rubber, reinforcing carbon black, zinc oxide, accelerators, anti-oxidants and softeners. This compound shall contain not less than 72 per cent by volume of new plantation rubber. The tensile strength shall not be less than 3,800 lb. per sq. in. with an elongation at breaking of 550 per cent. The unit stresses producing 300 per cent and 500 per cent elongations shall be not less than 1,100 pounds and 2,800 lb. per sq. in. respectively. The Shore Durometer indication (hardness) shall be between 63 and 68. After 7 days in air at 158 deg. (± 2 deg.) F. or after 4 days in oxygen at 158 deg. (± 2 deg.) F. and 300 lb. per sq. in. pressure, the tensile strength and elongation shall be not less than 65 per cent of the original.

The waterstops shall be molded

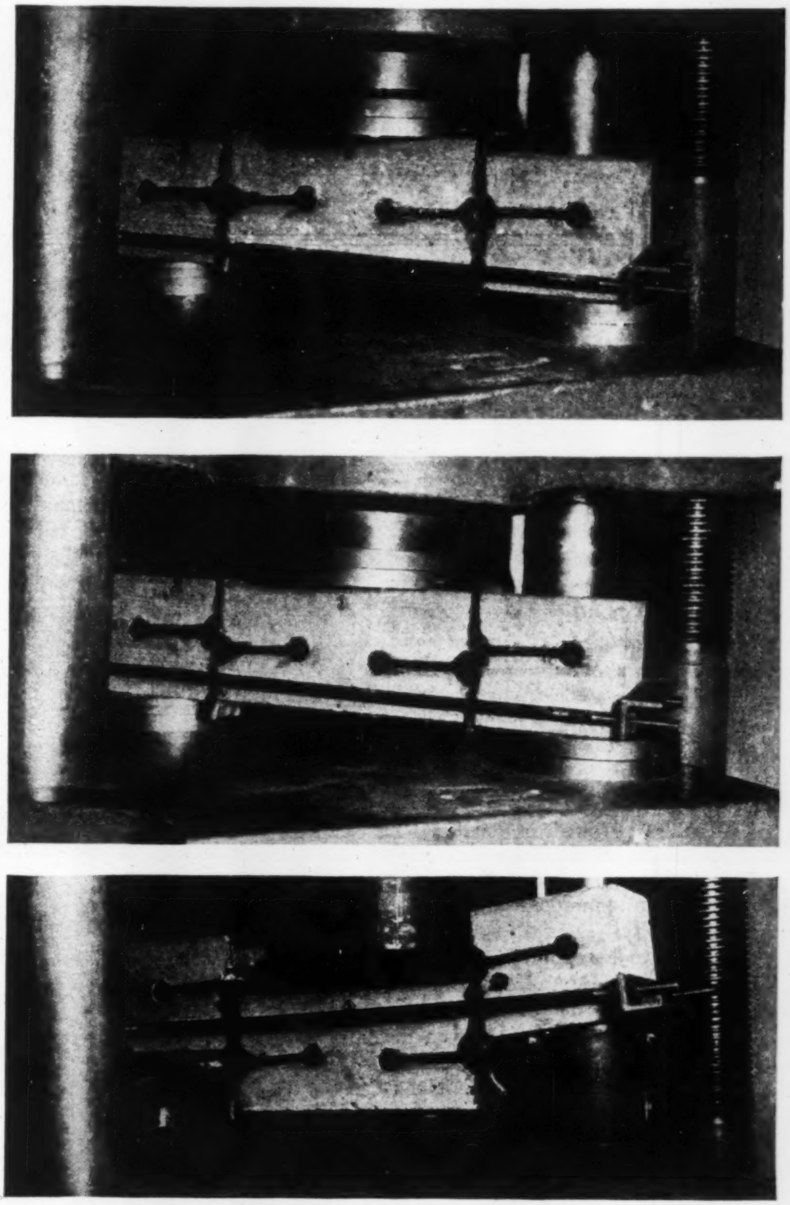


Fig. 4. Shear tests on one of the rubber waterstops showing effects of displacements up to 5 in.

with an integral cross-section. No splices will be permitted in straight strips. Strips and special connection pieces shall be well cured in a manner such that any cross-section shall be dense, homogeneous and free from all porosity. All junctions in the special connection pieces shall be full molded. During the vulcanizing period the joint shall be securely held by suitable clamps. The material at the spice shall be dense and homogeneous throughout the cross-section.

The molds may be of cast iron or mild steel, suitably constructed for continuous production, and the cavities may be unfinished but reasonably smooth so as to produce a uniform section with a permissible variation in dimensions of ±$\frac{1}{32}$ in. The manufacturer may construct the molds in such a manner that by blanking in certain portions they may be used for the manufacture of other sections.

Rubber stops under high heads

The experience of the bureau up to the present time, has been confined to the use in dams and structures sustaining a maximum head of 40 ft. However, conditions which led to the adoption of rubber seals for these structures under low and medium heads are also encountered in the case of structures under high head. The problem is made more complicated by the necessity for considering not only the impermeability of the rubber and the watertightness of the connection between the seal and the structures but also the permeability of the concrete surrounding the seal.

While concrete may be made highly impermeable, and is so made in concrete pipes, mass concrete in large dams may not be impermeable to the same extent. Consequently, to obtain the desired impermeability, it would be necessary either to produce concrete of a special mix for the region around the seal or to provide other means for reducing the pressure gradient of the water percolating through the concrete around the seal.

Fig. 2 shows a proposed seal along the latter lines. The surfaces of the joints are lined with corrosion-resisting steel plates for a width, in the up-and-down stream direction, depending on the head at the particular level. The seal itself consists of a heavy rubber slab bolted to castings embedded in the concrete on each side of the joint. The seal is supported on the downstream side by backing plates. Should replacement of the rubber seal become necessary an emergency seal may be inserted in the cylindrical space upstream from the permanent seal.

It is believed that this type will be satisfactory for use in dams of great height.

Types in current use

Rubber waterstops of Types A and B were developed in connection with the design of Imperial Dam and desilting works, under the author's direction. Type C was developed in connection with the design of the structures along the All-American Canal under the direction of H. G. Curtis, engineer, Bureau of Reclamation. In the development of the seals valuable assistance was rendered by the Gates Rubber Co. in Denver.

The design of Imperial Dam and the All-American Canal was under the supervision of H. R. McBirney, senior engineer. The Bureau of Reclamation is under the Department of the Interior, of which Harold L. Ickes is secretary, John C. Page, commissioner, R. F. Walter, chief engineer, S. O. Harper, assistant chief engineer and J. L. Savage, chief designing engineer, of the Bureau of Reclamation.

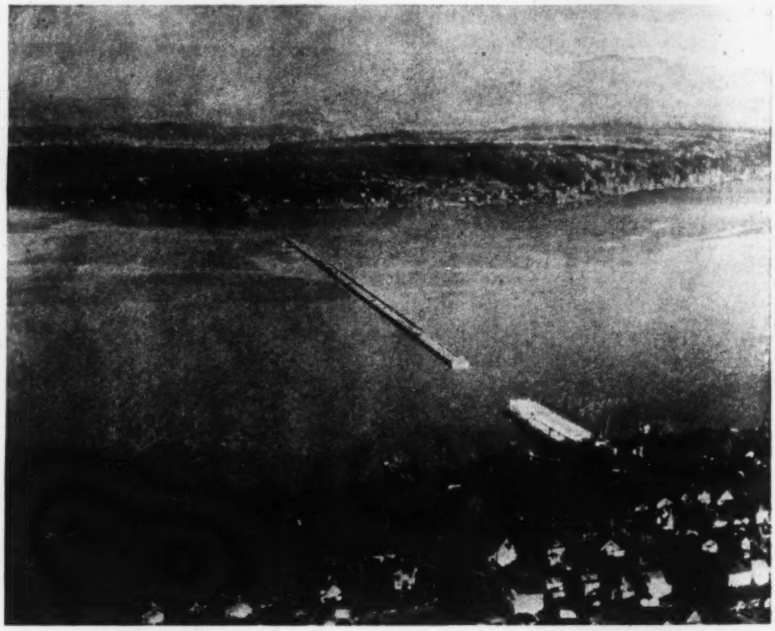
Watertight Concrete Pontoons For Lake Washington Bridge

***Contents in Brief**—After periods afloat ranging up to six months, concrete pontoons for the Lake Washington Bridge at Seattle have been found to be watertight and there is an absence of cracks in the deck structure despite the rich cement mix used. These results are attributed to the special care in selection and handling of materials and the precautions taken in curing. All pontoons are expected to be anchored in place and aligned by the end of February.*

Any question there may have been as to watertightness of concrete in pontoons for the Lake Washington Bridge is answered by the practical test to which they have been subjected. Those first built have been in the water for six months with wholly satisfactory results, according to a report on their condition from C. E. Andrew, principal consulting engineer, Washington Toll Bridge Authority. Data on the concrete mixes used are included.

By the end of 1939, twelve pontoons with a total length of 4,200 ft. had been put in place on the lake, connected to one another and fastened by cables to anchors previously put down on either side. (Total length of floating structure will be 6,561 ft.) Each pontoon has two anchor cables, carried out at right angles to the bridge center line, one on each side.

As to watertightness of the pontoons, Mr. Andrew states: "There is no evidence of any leaks through the bottoms or side slabs, so far as we are able to determine. The only water that has gotten inside the pontoons has come in through open hatches, which, until recently, had to be left open because workmen were continually going in and out. All cells other than those under the hatches have been perfectly dry—in fact, one could strike a match on almost any part of these floors. We believe it is safe to say there will be no leakage at all in these pontoons; as time goes on, the tendency will be for any pores that may exist to be stopped by particles in the water from the outside."



The general appearance of the floating concrete bridge can be judged by that portion of it that had been assembled before the end of 1939.

Every effort has been made to select materials and effect a concrete mixture that would give maximum density. With excellent concrete aggregates to choose from, the strictest requirements have been observed in preparing materials. The maximum size gravel used is 1½ in. as determined by a screen with circular openings of that diameter. Six sacks of cement per yard and 5½ gal. of water per sack of cement are used. An oil admixture (a new product recently developed at the University of Washington) is used in the proportion of one pint per cubic yard. After mixing one minute, the consistency of the concrete is such as to give a 5½-in. slump. This high slump is considered necessary to get the concrete placed effectively around heavy reinforcing in the relatively thin walls and partitions. All concrete is vibrated. Tests after 28 days have shown an average strength in compression of 3,835 lb. per sq. in., and an average weight of 148 lb. per cubic foot.

Thin walls and heavy reinforcing offered unusual difficulties in placing concrete and resulted in some imperfections on the outer surface of the bottom in the first pontoon. These were only discovered through the careful inspections made by divers after the launching and they were not serious enough to cause any leakage even after the barge had been afloat for months. However, to avoid any question, this first pontoon was drydocked and the thin spots were built up with shotcrete to specified bottom thickness of 8 in. No further defects developed on subsequent work after the technique had been perfected.

With concrete of the high cement content used on this job, there was concern at first lest there should be shrinkage cracks in the bodies of the pontoons. To prevent this, particular care is taken to keep the concrete continually wet after the forms are removed. On the inside of all walls as soon as the forms come off, an application of heavy black oil is made. Mr. Andrew reports that in the first six months of the work no cracks of any importance were found in deck slabs 60 ft. wide and 350 ft. long. After the pontoons are launched, of course, there is immediate stoppage of any tendency to shrink in the outer surfaces that are below water line.

By the end of 1939, all the pouring was completed except on pontoons for the moving span assembly which are "specials". It was expected that all pontoons will be completed by March 1, 1940.

Pontoons already in place on the lake have had their anchor cables drawn up only in testing out security of anchorages. Working tension in each anchor cable will probably range from 20,000 or 25,000 lb. up to 65,000 or 70,000 lb., depending upon the lengths. Final adjustments will not be made until the entire bridge is assembled in position so that the operation of effecting exact alignment can be carried out.

The Lake Washington Bridge is being built under the supervision of the Washington Toll Bridge Authority, L. V. Murrow, chief engineer; C. E. Andrew, principal consulting engineer. The contract for the floating structure, comprising Unit No. 4 of the entire bridge and highway project, is held by Pontoon Bridge Builders, an organization made up expressly for this job by J. H. Pomeroy & Co. Inc.; Parker-Schram Co.; Puget Sound Bridge & Dredging Co. and Clyde W. Wood. The Pomeroy Co. acting as job managers for the contracting firm have the following men on the job: C. F. Urbutt, general superintendent; Frank Van Antwerp, in charge of graving docks; Jack Haglund, carpenter foreman and Jack McDonald, in charge of pontoon assembly on the lake.

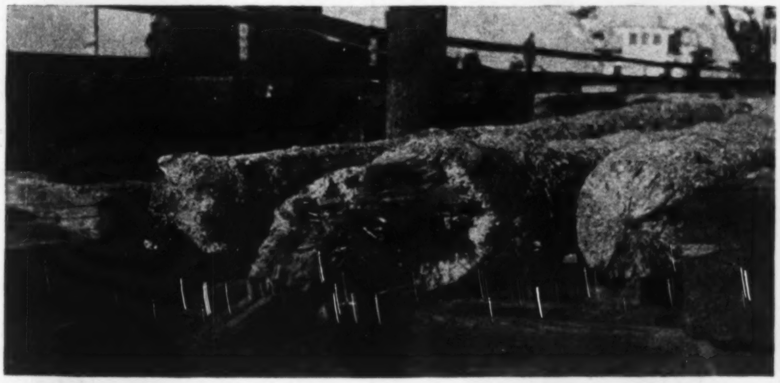
Teredos Cause Collapse Of Temporary Trestle

AN UNUSUALLY SEVERE ATTACK of teredos on the piles of a temporary trestle built by a contractor working on a jetty at Fire Island inlet on Long Island, caused the collapse of three bents of the trestle on Oct. 6 last, just three months after the trestle had been built. The piles that failed completely were second-hand spruce that had been in service in the polluted waters of Long Island Sound near North Beach since 1924, but examination of the trestle showed that new piles and bracing in the trestle had been so badly attacked in the same period as to require replacement. The second-hand piles were sound when driven and had not been subjected to attack by any type of borer until after they had been installed in the temporary trestle at Fire Island on June 30, 1939.

The trestle where the attack occurred is on the land side of Fire Island. It was put up by the firm of Spearin, Preston & Burrows, contractors for the U. S. Engineer Dept., for unloading stone for a rock-filled jetty being built at Fire Island Inlet. The pile bents where the worst attacks occurred were 150 ft. off shore where the water is about 6 ft. deep at low tide. The attacks extended from the mud-line to low-water elevation, with the most severe attack 2 to 4 ft. below mean low water.

Examination of the trestle by a diver indicated that there had been severe attacks on all kinds of wood in the pile bents, including spruce, white pine, Southern yellow pine and oak. Heavy attacks were found in the 4x12-in. braces of untreated Southern yellow pine. As a result of the examination of bents other than those that collapsed, the trestle has been reinforced with new oak piles, some with bark on and brush treated with creosote, others wrapped with paper felt and galvanized iron in the zone of heaviest attack.

Laboratory study of all types of timber taken from the trestle show that the attack had been made entirely by teredo navalis, a type of marine borer that has been plentiful in certain areas at Fire Island for a long time. The 1939 attack was more severe than any previous record, which is true of most points along the North Atlantic seaboard that are free of pollution.

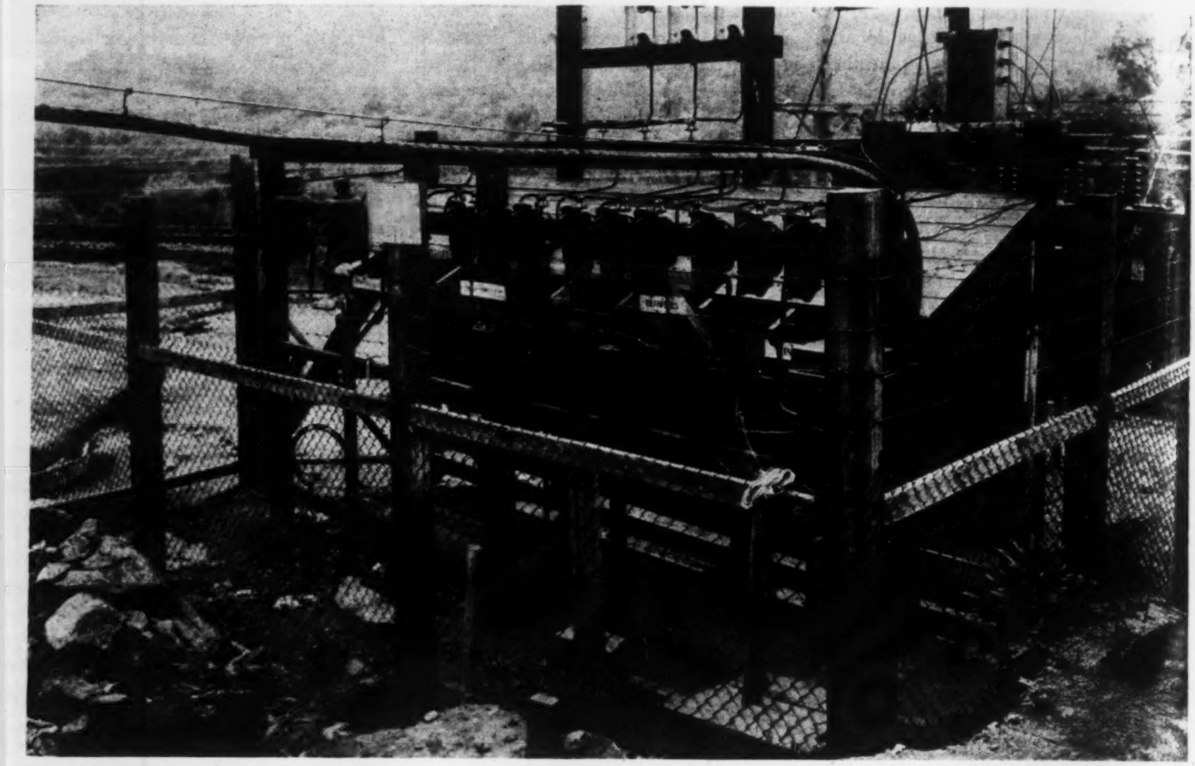


Broken piles showing effect of teredo attack. The outside piles are old pine, but the center pile is new oak.

• • •

Fly-Pest Control At Sewage Filters

Although the psychoda fly, a common pest at trickling filters, is seldom found in large numbers at filters containing a large population of water springtails (achorutes viaticus), it is stated in "The Digester" (bulletin of the Illinois State Department of Public Health) that there is a general reluctance to ascribe fly control definitely to the presence of the springtails. For a practical experiment, Illinois state engineers have obtained "seedings" of springtails from the plant of the Elgin Sanitary District, which formerly was infested with the psychoda fly, and have seeded the filters at Clinton, Litchfield and DuQuoin.



OUTDOOR SWITCH BOX FOR POWER FOR HOISTS, COMPRESSORS AND BLOWERS, ETC., IN A TUNNELING OPERATION.

Electric-Drive For Ordinary Jobs—I

Getting Power To the Job

George H. Hall
Mechanical Engineer, Douglaston, N. Y.

***Contents in Brief**—Electric power is not confined to large operations. It serves the small and large contractor equally well, extends their choice of power sources and has distinctive advantages of small working space, lack of fumes, few operators and possibilities for remote control. Job installation and distribution equipment is simple. Common troubles are easily handled. This is the first of a series of articles on modern electrified construction equipment.*

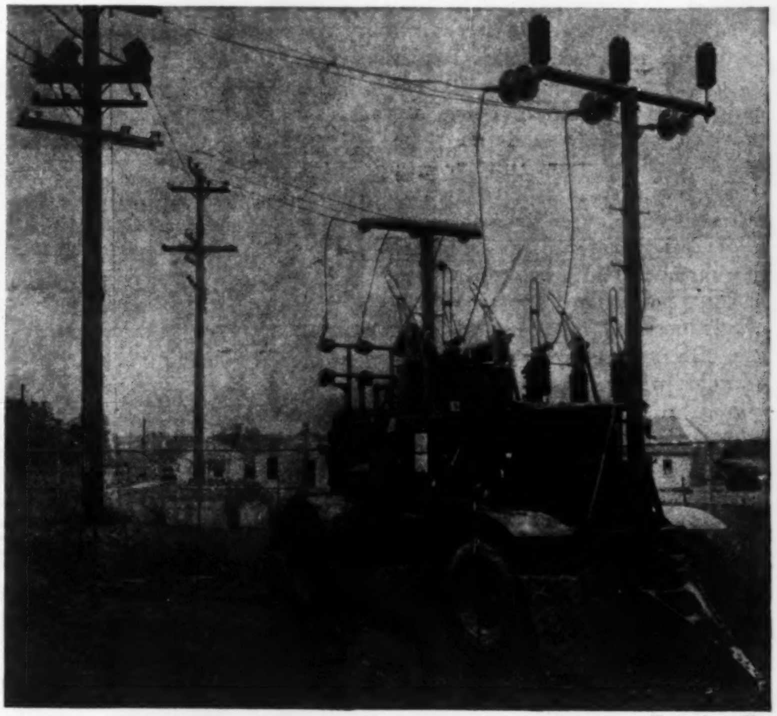
Electric power for construction equipment has obtained wide employment. It has happened, perhaps not altogether to advantage, that this employment has been most notably in large operations continuous over a number of years. While Grand Coulee, Fort Peck and the Tennessee valley dams and the astonishing profusion in the last few years of other large engineering works have brought electric power prominently into the construction picture, they also have given an impression that its approved place is in large centralized operations having special technical staffs and not in scattered construction. This is entirely wrong.

Electricity adds to the sources of power that the contractor now commonly draws upon, another source having distinct advantages. Also there is nothing mysterious, or even involved in electric power as contrasted with steam or gas or diesel power that cannot be mastered by ordinary field management in construction.

To make these facts plain this article and others to follow will discuss for the general constructor the limits and advantages of electric power, the characteristics of power sources, the suitable types of motors, the usual operating troubles, and a number of specific equipment applications.

Why consider electricity?

As stated, the claim made by electricity for the contractor's consideration is that it extends his choice of power sources. By its use he can gain certain advantages. For example electric power has a distinct advantage in operations where working space is limited or is enclosed. A tunnel is an example. With electric power there are no fumes that with other sources of power call for special provisions for ventilation. The space required for electric motors is also considerably less than that required for any other type of power unit. Also no operator is required for an electric motor as is usual for a gas or an oil engine; the electrician who looks after the lighting circuits can give the motors all the attention that they normally demand. The power supply of the motor is smoother and there is less noise and vibration with motors than with fuel engines of any type. Outstanding among the advantages of electrified equipment are those of remote control and speed variation. Neither of these features, to be sure, is needed on all types of construction machinery but there are many instances where one or both are of great value, at times a necessity, and in no other way can they be secured with the ease and convenience that is offered by electrical control. Both features will be discussed in later articles in connection with the specific types of machinery with which they are employed.



Westinghouse Photo

Truck-mounted substitutions transform high voltage commercial current to job voltages required for machine operation. These units complete with transformer are assembled in light compact form to suit the ordinary job demands.

Power set-up is simple

Commonly the contractor will buy his electricity. It will then most probably be delivered to the job at 13,000, 23,000 or a higher voltage. This must be transformed down to a voltage that may be employed for power and light; for this purpose complete and convenient field transformation stations have been developed by electrical manufacturers. For a single incoming and outgoing line, for voltages not exceeding 15,000, the standard switching station consists of a single galvanized, weather-proof housing containing all necessary disconnecting switches, circuit breakers, meters and connections, so that the user need only connect the incoming and outgoing leads and make a proper ground connection. For higher voltages, or for more than one incoming line, the station is somewhat varied in detail but is correspondingly simple and convenient of installation.

The voltage of the job distribution system will depend upon whether the machines to be operated are closely bunched or widely distributed. When all machines are comparatively near together, the primary distribution may be of the lower working voltages; if they are far apart it is advisable to employ a secondary distribution system and to establish a number of transformer points at which this voltage is further reduced to the working voltage of 110, 220, or 440. For job distribution to the individual motors a voltage of 220 or 440 is to be recommended, the latter involving lower distribution losses and requiring smaller wiring. For lighting and for any small tools which may be equipped with single-phase motors, a lighting transformer having a secondary voltage rating of 220/110 volts should be used.

While the voltage at which the current is distributed by the public utilities will probably vary in different localities, it is now virtually universal practice to employ a frequency of 60 cycles. Distribution is also practically standardized at three-phase with either a three- or four-wire system. If in any locality a departure from these standards of frequency or phase is encountered, the utility station from which the power is obtained should be consulted before equipment is ordered. Certain types of construction ma-

DANGER 4000 VOLTS
DANGER
4000
VOLTS

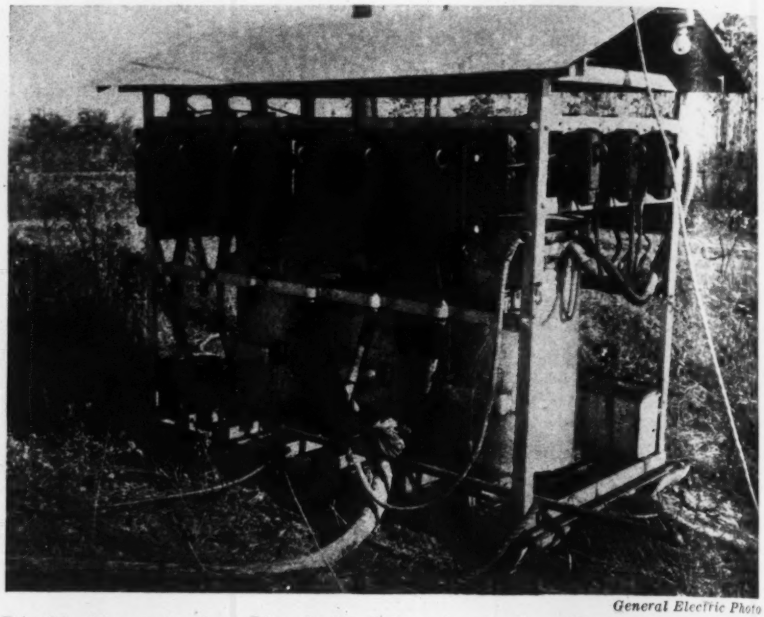
General Electric Photo

Two arc-welded all-steel portable transformer stations for delivering 220-volt, 3-phase power to drills, pumps and air compressors.

chines, particularly shovels and some types of hoists, are better suited to the use of direct current motors to obtain more favorable starting and control characteristics than are provided by the wound-rotor type of alternating-current motor. In such cases a small motor-generator set is employed which consists of a squirrel-cage motor direct-connected to a direct-current generator. Motors on large power shovels are most efficiently operated by a variable-voltage, direct-current system the details of which will be discussed in a following article on shovels.

So far, consideration has been given to power as supplied by commercial power companies. An alternative is an independent power unit that may be installed to serve a single large machine or a group of smaller machines or to start operations before commercial power can be delivered or to serve isolated parts of the work. A number of small generator combinations are available for such temporary power supply and the selection will be governed by the amount of power to be furnished and whether it is to be used for a long-continued job or just as a stop-gap supply on a short job or for a limited time until a regular central-station supply can be brought into the project.

The most efficient and convenient installation consists of a generator, of the required capacity, mounted on a common sub-base with, and direct-connected to, an internal combustion engine. The smaller units are usually driven by a gasoline engine and the larger by a diesel engine, although this will depend upon the more readily available source of fuel. Such sets generally have a switchboard with a main switch, sometimes a circuit breaker and a number of fused distribution switches, all mounted on a slate or asbestos board supported from the sub-base so that the entire unit is self-contained and requires no further installation than erecting on a fairly firm foundation and connecting to the motor, or motors, which it is to drive. Such sets are usually equipped with direct-connected exciters. Since these sets can be mounted comparatively near to the motors, they are generally built to supply current at motor voltage, preferably 440 volts, so that no transformers are required other than for the lighting and a limited single-phase supply.



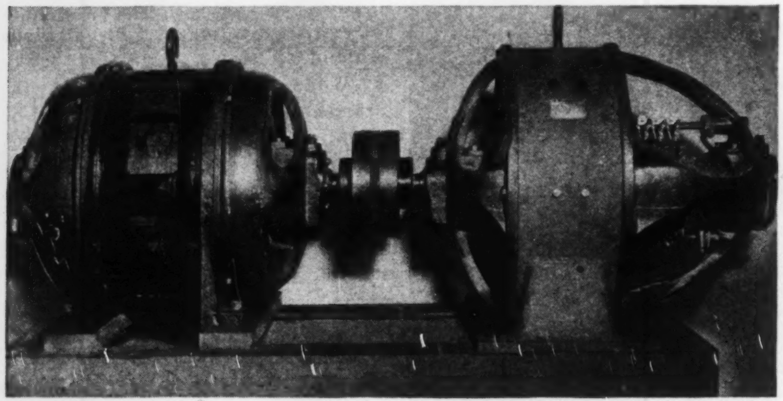
General Electric Photo

Portable fuse station for a shovel; for lightning protection, this equipment consists of three fused cut-outs fitted with 200-ampere fuses.

In many localities fuel is abundantly at hand so that the prime mover may be a small steam engine direct-connected, but more usually belted, to the generator. Steam for the operation of such a set can be supplied from a donkey boiler which may be fired with either coal or wood as may be most accessible. Viewed from a strictly engineering standpoint such a combination is of relatively low efficiency but, when located where fuel is free, and since it requires but little in the way of attendance, the practical efficiency, as compared with the cost of bringing in long lines for high-tension supply and the transformers involved, is very satisfactory.

A third method which is more or less of a makeshift, but which will in some cases fulfill all the requirements, consists of using a small belted generator and exciter. An auto-truck is jacked up, one of the rear wheels removed and a pulley for either flat or V-belt substituted. When the main consideration is that of quickly and simply obtaining a small power supply such a combination will often prove economical and satisfactory.

A following article will describe and discuss the types and characteristics of motors and their suitability for various conditions of service.



Westinghouse Photo

Motor-generator unit designed primarily for fixed installation but adaptable for truck mounting if the stand is firm.

Everybody Is an Engineer Today

HENRY W. TAYLOR
Consulting Engineer, New York, N. Y.

When Farley Gannett raised the question, "Why so few famous engineers today?" (*ENR*, Aug. 17, 1939, p. 266) and inquired into the reasons why present day names did not stand out with clarity and brilliance, he called attention to an undeniable fact and prompted a search for adequate answers. Such a search has given rise to several comments which hopefully point to the same central subject from various circumferential ranges.

Ethyl Gasoline Corp.

"Wonder ef'n she needs high compression?"

Not so many years ago (and this phrase must not be casually read) the farmer did his work with plows, harrows, wagons and horses. He knew how to take care of his horses, and the only mechanical work he was forced to do involved chiefly nuts and bolts, a well rusted monkey wrench and a pardonable amount of profanity. No roadbuilding disturbed his tranquil farm; no transmission lines cut through his wood lot; and never did he see any big engineering-construction works. His sanitation facilities were primitive, if they existed at all. He had no telephone, radio, motor car, tractor, milker, concrete mixer, or any of those numberless machines that are now a normal accompaniment to his existence.

Neither was the average householder surrounded by an atmosphere of mechanics or engineering. His sanitation facilities consisted of a well-advised clump of lilacs and a distant door. His heating equipment was a stove, and he shovelled coal in and ash out. The telephone was a curiosity and radio was unheard of.

Literally, not so long ago, the legislature of the State of New York, in a moment of complete abandon and with a reckless flourish, appropriated six hundred fifty dollars for the preliminary survey of the then proposed Erie Canal from Albany to Buffalo, inclusive.

Against this background, the engineer stepped forth to develop a water supply project, a suspension bridge, a railroad tunnel, or a subway. Against this background, any engineering exploit involved mystery, wizardry, pioneer boldness and skepticism; universal talk arose concerning this new thing that sprang from the brow of genius upon an unprepared and unsophisticated world. And although the engineers of those days received none too much credit and renown, they did operate against a setting which easily yielded a spontaneous acknowledgment of their daring, skill and ability.

But time marches on. Today the farmer installs his own concrete structures; he knows all about motor cars and tractors; he has seen intricate machines build the state road along his farm; and he has an intimate knowledge of electrical accessories and their repair. He has a radio that can be tuned to stations all over the world and the telephone is a commonplace necessity. This farmer not only has all these things—*handles* them and *possesses* them—but he knows and talks familiarly about transformers, amplifiers, concrete mixtures, gear reducers, vacuum systems, insulation, and what not. In fact HE is an engineer.

And the householder in the village or city has studied the problems of efficient heating, of satisfactory plumbing, of best radio reception, of street drainage and paving; he also inspects the new central electric station as well as municipal construction of all varieties. In many ways, he too, is an engineer.

So it is that engineering has been translated from the purely specialist field into the realm of personal intimacy. Even our advertising is full of engineering facts and fancies, and we are urged to buy this or that on the basis of real or alleged engineering principles.

Against this modern background the great engineer becomes a brother engineer. He is not a wizard, but is appreciated with a certain amount of engineering sophistication. He is no longer outside the range of popular understanding.

And one thought more: The great engineer of today is not an individual but a composite entity whose spirit embodies many branches of engineering skills. Genuine preeminence of the individual will probably be obtained only in one engineering branch, with the exception of that man who, though an engineer in some special branch, has the organizing ability to conceive, finance, complete and operate a huge project of world interest which includes a composite of engineering, finance, management and personal force and magnetism.

The corporations, including industrial, federal, state and municipal, are a factor in a natural submergence of tip-of-tongue engineering names. The industrial corporation rarely advertises the engineers with the product, the main exception being Edison and Steinmetz. The renown these men shared was by no means undeserved but its scope would have doubtless been much less were it not for the organizations behind them. The engineer's achievements may be headline material, but the name of the product of "our engineering department" is the name to be remembered. In the case of federal work the remembered name is that of the project.

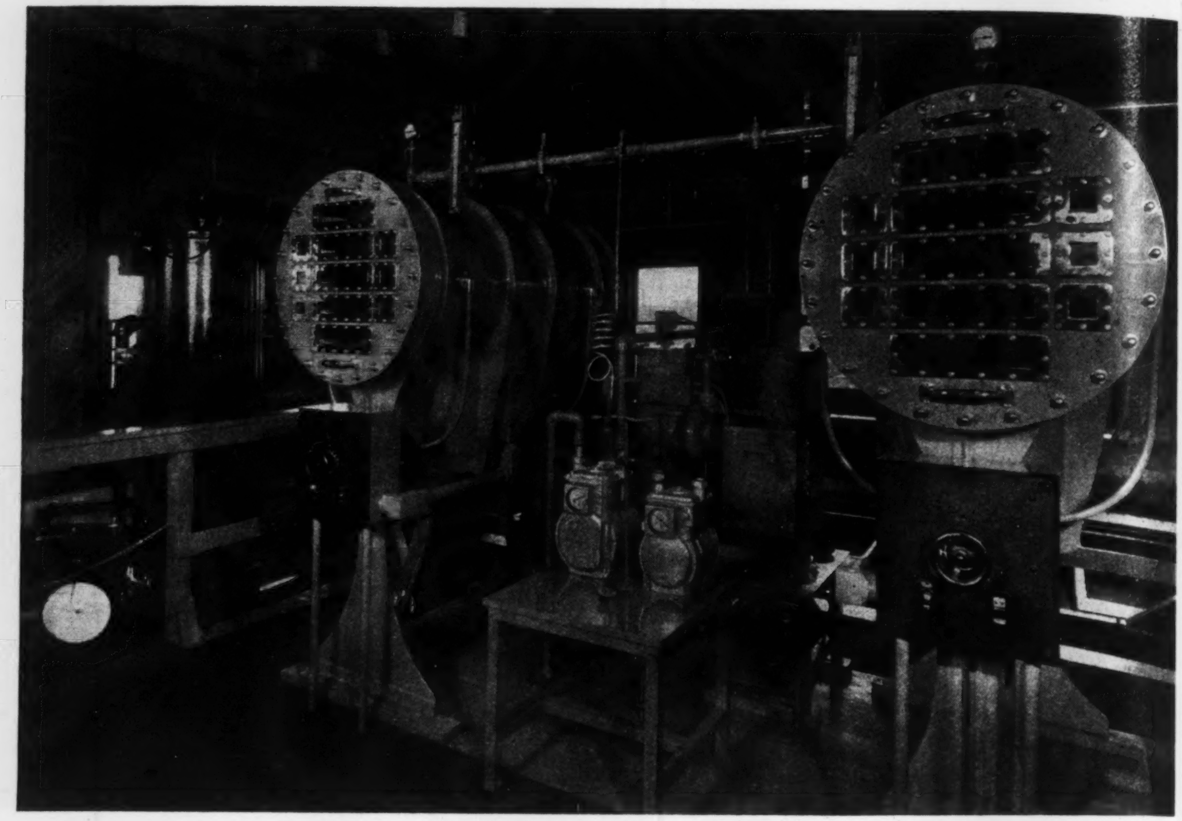


FIG. I. OZONE GENERATING AND DIFFUSING EQUIPMENT SET UP FOR RESEARCH STUDIES.

Ozone for Water Treatment

J. B. Klumpp
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Philadelphia, Pa.

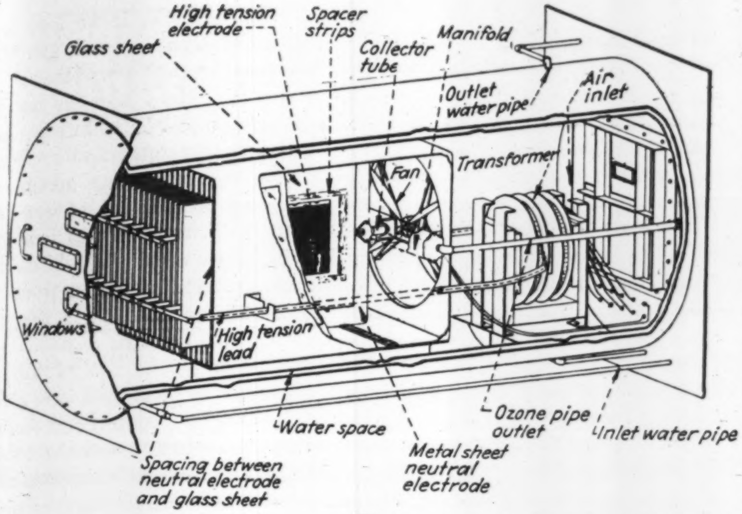
Contents in Brief—Development of new equipment for the generation of ozone and for its diffusion in water calls attention to the use of this gas in water purification. Details are given concerning the application and cost of the process based on recent findings.

New equipment now is available to generate ozone economically and in sufficiently large quantities for the treatment of water in municipal purification plants. While the ozone process itself is not entirely new—having been used extensively in Europe for years, especially in France, Germany and Soviet Russia—its application on a practical and economic basis is new in the United States.

The ozone process generates ozone by passing thoroughly filtered and dried air under pressure through the silent blue corona discharge created between dielectric plates at high voltages. Ozonized air is applied to the liquid to be treated under pressure and mixed in it with electrically driven agitators. Generation of ozone is essentially an electrical operation but the action of the ozone itself in the purification of water and the removal of tastes, odors, and discoloration is distinctly chemical and physical.

Ozone has long been recognized as a powerful bactericide. In the literature of organic chemistry, the testimony of such world-famous bacteriologists as Pasteur and Fremy in France; and of Bunsen, Rideal, and Houston in England, offers conclusive evidence of its potency as a germicide. Because it has no equal as an immediate and effective oxidizer, it is an ideal agent for water purification.

Since it was discovered in 1785 by Van Marium and named "ozone" by Schoenbein in 1840, it has been a constant source of interest to chemists and scientists generally. Ozone is a gas under ordinary conditions, though it may be condensed to a deep blue magnetic liquid, boiling at —119 deg. C.; as soon as it is formed, ozone strives to return to stable oxygen. A molecule of ozone consists of three atoms, as compared with two atoms for atmospheric oxygen. In other words, a molecule of ozone occupies the same volume, but



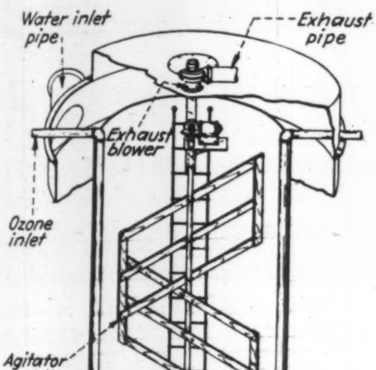


Fig. 2. Ozone is generated in the "ozonator" by means of a high-voltage electric charge through which desiccated air is passed; this size unit has a capacity of 10 lb. ozone per day. From the generator ozone is piped under pressure to the "ozonizer," where it is mixed with the water to be treated; the unit is designed for a 7½ min.-detention period.

weighs one and one-half times as much, as a molecule of atmospheric oxygen. For our purpose, it can be assumed that ozone is composed entirely of oxygen, with the further assumption that ozonized or electrified air contains ionized oxygen atoms, which may reasonably account for the ready ability of ozonized air to bleach and purify water by oxidizing matter in solution or in colloidal suspension.

Background in development

There have been several reasons why ozone treatment has not been adopted in the United States, the principal ones being the lack of suitable equipment to fit American production conditions, and the cost of operation when higher electrical energy rates were prevalent. Neither reason exists today, for equipment especially designed for American conditions is available and its average cost of operation is less than its chemical competitors.

The initial credit for this belongs to J. M. Daily, an American engineer, who spent several years with the leading French company manufacturing and installing ozonation equipment for waterworks operation. Looking at the problem from an American engineering viewpoint, Daily launched a program of research and experimentation to determine the practicability of his ideas. The ozone process and its equipment, to be discussed in this article, owes its origin to Daily's efforts over the last ten years. His basic specifications are incorporated in the equipment designed by Ozone Processes, Inc., of Philadelphia, which company has taken over the patents, etc., of the American Ozone Corp., of which Daily was one of the founders.

Two earlier installations in the water purification field were pioneers in the development of today's equipment. One of these is at Long Beach, Ind., and the other at Hobart, Ind.; they have been in service continuously since 1930 and 1932, respectively. While their energy requirements are considerably higher than present equipment their ability to purify and produce palatable drinking water, is a matter of record.

The chemical principle of ozone application is really that of immediate oxidation, or super-aeration. Ozone, as previously stated, is relatively unstable and immediately on generation it tends to revert to molecular oxygen. One atom of oxygen becomes a "free agent" in this process and attacks organic and mineral matter to oxidize them. Accordingly, in the field of water treatment, ozone is employed to directly destroy pathogenic bacteria and also the organic matter on which they thrive. Furthermore, by oxidizing matter in colloidal suspension, it removes those chemical constituents which otherwise, in combination with bactericidal chemicals (should they be used), produce the residuals causing those bad tastes and odors frequently found in chemically-treated drinking waters.

Large-scale operation

It can be fairly claimed, I believe, that Daily was the first engineer in the United States to think in terms of ozone generation and application on a large scale and instigate the necessary research towards its scientific development for practical use. Small ozonators, with capacities rated in grams, have been available for years; in all fairness, they are to be recognized as entirely adequate for their purpose, such as ozonating air or treating limited quantities of prefiltered water. But the very limitations of their capacity made operating efficiency a relatively unimportant factor in terms of accomplishment. However, such efficiencies translated from gram to pound capacities, such as are necessary for municipal plant operation, would be prohibitive.

Many factors of minor importance in very small ozone generators assume major importance in designing large generators. For example, the efficiency of an ozonator (ozone generator) is definitely related to the condition of the entrained air for ozonation. To attain maximum efficiencies, its volume must be accurately controlled. The air must be thoroughly filtered. In one ozone installation for the treatment of 3.5 mgd of water, an electrostatic precipitator has been specified for this purpose. It has the advantage of cleansing the air completely of harmful dust and fine particles, which aids greatly in the generation of ozone. Pre-cleansing protects the dielectrics and prevents lowered efficiencies due to dirt accumulations.

After the air is thoroughly cleaned, it is compressed electrically, or otherwise, and forced through a preliminary air-drying system. The compression of the air, if carried high enough, is an efficient precipitator of moisture, provided the moisture is removed during compression. Otherwise the air must be forced through some moisture-absorbing apparatus and thoroughly dried before being ozonated.

Finally, after being thoroughly cleansed, dried, and cooled to the proper temperature, the air, under electrical pressure, is passed into the ozonator. The resulting ozonized air contains approximately 0.5 per cent of ozone by volume, but ozone is so powerful a bactericide that it is quite adequate for our purpose. In practice, a constant air volume is maintained, the ratio depending on the requirements of the water to be treated. The quantities of ozone produced are controlled by varying the voltages on the electrodes in the ozonator. The process is designed for 60-cycle a.c. current. Details of the equipment developed to generate and diffuse ozone in water are shown in Fig. 2.

Energy demands and cost

Research at an experimental station in Moorestown, N. J., shows that over-all efficiencies from 9 kwh to 14 kwh per pound of ozone generated and applied are obtained so constantly as to establish them as basic consumption with today's equipment. The variation, due to atmospheric conditions will be readily apparent to the electrical engineer, who is familiar with the relationship between seasonal relative humidities and their effects on the electrical demands for air-conditioning.

The data indicates that 14 kwh per pound of ozone generated and applied is a generous maximum and indicates a maximum energy consumption contingent on the number of pounds of ozone needed per million gallons in any particular water treatment situation. What quantities of ozone can be anticipated in water treatment? It is hard to generalize due to the many variables in raw water characteristics.

At Whiting, Ind., where a particularly difficult treatment problem was encountered, due to industrial waste and sewage pollution, the ozone process in a test pilot plant succeeded in producing a palatable water, where all present chemical methods had failed to remove the "iodoform" or "medicinal" tastes and odors. (The pilot plant had a capacity of 3,600 gal. per day, and it served as the basis for design of a 4-mgd plant now under construction.) The peak ozone demand, when seasonal raw water is worst, was estimated to be 15 lb. per million gallons, though the average will be less than 10 lb. per mil. gal. So, if we assume that 10 lb. of ozone per mil. gal. will be adequate to treat worse than average water conditions and our maximum energy demand be 14 kwh per pound of ozone generated and applied, we arrive at an average maximum of 140 kwh per mil. gal. of water to be treated. With electrical energy as high as two cents per kwh, the maximum cost for ozonation would only be $2.80 per mil. gal. In that ozone reduces the chlorine demand to zero and obviates the use of absorbent chemicals in most instances, a resulting saving in chemical cost can probably be credited to ozone and thereby further reduce its operating cost at water treatment plants.

Planting Difficulties In Highway Landscaping

LOCAL CONDITIONS affecting the landscaping of approaches to the San Francisco-Oakland Bay Bridge are described by H. Dana Bowers, landscape engineer, in "California Highways and Public Works" (bulletin of the State Division of Highways). Due to severe offshore prevailing winds carrying salt spray across the road and to the dredged fill of sand and clay in which the planting was done, there were difficulties in selecting the plants.

A solid screen planting was made on the east and south sides of the Oakland approach to conceal the industrial district and the interurban railway from view. Groups of cypress were placed to break up the formality of the continuous shrub mass and give skyline effects. All planting was done thickly so the plants would protect each other. Shrubs that normally would be 10 to 15 ft. apart were here planted from 3 to 5 ft. apart. From the bridge to the distribution structure the road lies in the direction of the prevailing winds, with the planting mainly between the road and the railway. No wind burn or distortion is noticeable.

From the distribution structure northward, the conditions are much more severe, with slight protection from Yerba Buena Island and Treasure Island. The winds have an unobstructed sweep over the bay from the Golden Gate, and while the growth has been fair, the plants are prostrate and there is some burning from the salt spray and the wind. Plantings against buildings in an area of "dead air" show no wind effects and made a normal growth. The plants succeed better in front of the wind breaks, rather than behind them, due to the lack of eddies or drafts.

Before planting it was necessary to place all plant material in a semi-exposed location for several months, for acclimatization. Without this, even the hardiest varieties taken directly from the protection of the nursery would burn to the ground immediately under the force of the wind. On the bay side, all planting was confined to ice-plant ground cover, and in spite of the drenching from salt spray it has made a satisfactory cover.

When the Fifth St. plaza approach in San Francisco was planted in May, 1937, large boxed specimen coniferous material was used, in order to give an immediate effect for the opening of the bridge. But the effect of the prevailing winds has made it necessary to replace cypress with broad-leaved evergreens and shrubs.

Influence of Cement and Aggregate On Concrete Expansion

THOS. E. STANTON, JR.
Materials and Research Engineer, California Division of Highways

Contents in Brief—Following serious deterioration of a concrete pavement, careful search for causes showed that relatively high alkali content in the cement caused destructive chemical combinations when chert and shale were present in aggregates. Good concrete can be made with the same cement or with the same aggregates so long as the combination is avoided. Accordingly, for certain localities, cement specifications of the California State Division of Highways henceforth will limit total alkali to 0.50 per cent.

EXCESSIVE and destructive expansion in concrete pavement on a state highway in the Salinas Valley, Calif., led to an investigation that has brought out new information on causes of this and perhaps other cases of defective concrete in a strip of coastal territory extending from the Salinas Valley some 200 mi. southward. After the cause was traced to reactions between alkali in the cement and chemical ingredients of chert and shale in the aggregates, extensive tests were made with cements from widely divergent sources with varying, but carefully determined, alkali content. Results were consistently confirmatory. Later, discussions with authorities East and West brought forth nothing to refute the findings, and accordingly the California Division of Highways has changed its cement specifications to include a top limit on alkali content for regions where the deleterious materials occur in aggregates used in making concrete.

The defective pavement that focused attention on the matter was a 6.83-mile length of 20-ft. standard construction which met specifications of the state highway department in all respects. Most of the concrete had passed through two winters when signs of distress in the form of excessive expansion began to appear early in 1938. The effect was buckling at the expansion joints and a severe crazing throughout the length of certain slabs; the condition was such that in the worst spots the pavement began to go to pieces under traffic. Fig. 1 shows typical appearance of the surface.

Aggregate suspected

All coarse aggregate used on this job came from a gravel plant on Oro Fino Creek, a tributary of the Salinas River. Fine aggregate came from two sources: one, the Oro Fino deposit and the other at Coyote some 135 miles away. Fortunately, sands from these two sources were used on alternate days, hence it was easy to identify the source of the fine aggregate in each section or day's run.

Suspicion at once centered on Oro Fino materials because serious defects had developed only in section on which fines from that source had been used. However, adjoining the pavement on which the destructive expansion occurred was other concrete paving constructed six years earlier in which fines from the Salinas River (of composition presumably similar to those from Oro Fino) had been used and which was still in excellent condition.

On the other hand, there are numerous examples of deteriorated concrete in this coastal region from Monterey to and including the northerly part of Los Angeles County. Throughout this region, gravel in the local streams is of the same general mineralogical character. A typical instance is the seawall in Ventura County of which a view is shown in Fig. 2.

Laboratory studies

The best efforts of the state highway laboratory at Sacramento were focused on the search for causes of failure because if they could be determined in this instance it was likely that light would be thrown on the similar cases throughout the coastal area heretofore unexplained. Test specimens of mortar and concrete were made up with Oro Fino and Coyote fines and coarse aggregates; the usual wide range of laboratory conditions was imposed including

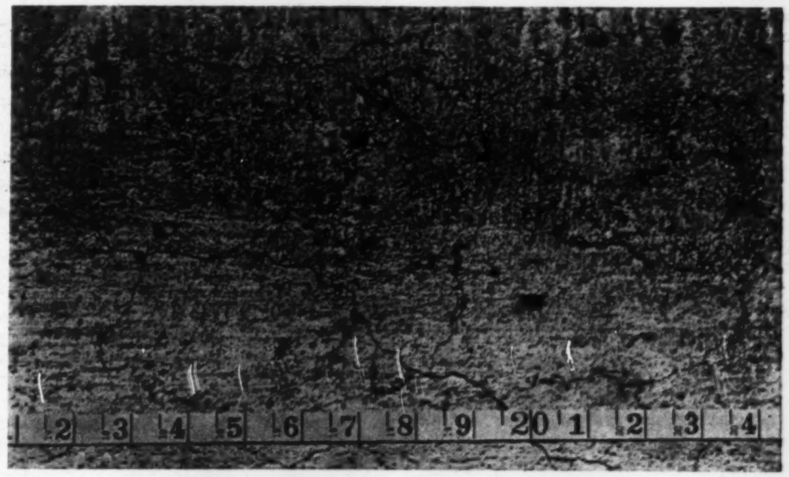


Fig. 1. Typical cracking of pavement surface as the result of excessive expansion.

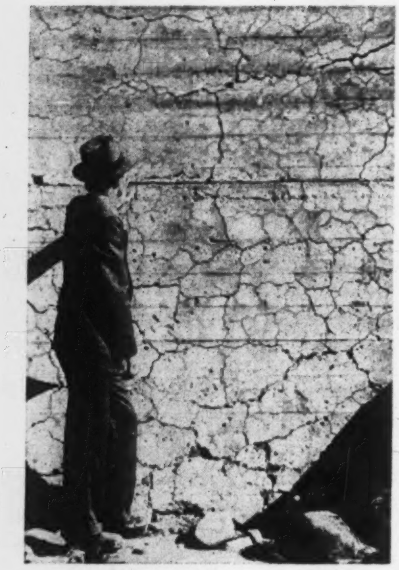


Fig. 2. Portion of a seawall 12 years old in Ventura County. Cement had a 0.98 per cent alkali content and sand contained shale and chert.

constantly wet, constantly dry, normal laboratory temperature and humidity, alternate wetting and drying. Oven drying and hot water soaking in alternating cycles was included.

Under none of these tests, some of which continued for more than a year, was any excessive expansion observable except in the case of a coarse aggregate that was 100 per cent shale. In this case the expansion was obviously due to a physical expansion of the shale. When shale is present in large quantities the effect may be ultimately to rupture the concrete. However, in normal percentages (say 5 per cent or less) common to the aggregate under suspicion, there was no measurable deleterious effects for the period under observation and in the curing procedures used. In the case of the coarse aggregate of 100 per cent shale, failure occurred on the 51st cycle of wetting and drying at which time expansion was 0.193 per cent.

An accidental discovery

Meantime, however, upon removing the cover from a tightly closed 2x4-in. cylinder in which mortar had been retained for a year, the specimen was observed to be covered with blotches and ringed with a white efflorescence. In a short time the entire specimen became covered with cracks similar to the crazing noted in the pavement and the other structures that have deteriorated in this area. Conditions of this sample were similar to that shown in Fig. 4.

This discovery suggested that when kept constantly moist in sealed containers or otherwise protected from the atmosphere so as to prevent any leaching of salts by constant immersion or alternate wetting and drying, some kind of chemical reaction was taking place which resulted in excessive expansion of the mortar and failure of the concrete.

Accordingly, a series of tests immediately was started on 1x1x10-in. mortar bars cured in sealed containers and measured for expansion at different ages. Subsequently, hundreds of specimens have invariably checked the results accidentlly noted in the original 2x4-in. mortar sample. The expansion of bars made with the same sand and the same cement has invariably shown the same characteristics in the matter of expansion.

In other words, the Oro Fino fine aggregate in combination with the cement used on the job under examination, always shows excessive expansion in a few months—a considerable amount even at 28 days—while the Coyote sand with the same cement has shown negligible expansion for periods exceeding a year.

Alkalis react on aggregate

Alkali in the cement in the form of sodium oxide was suspected as a contributing factor because it seemed possible that the expansion might result from a combination of certain ingredients in the aggregate with these alkalis. Cement used in the pavement that showed the worst failure contained about 1 per cent total alkali, computed as Na_2O. Hence the tests were repeated with another cement low in Na_2O (0.40 per cent). This test gave the startling result that there was little if any expansion when using the same sand that showed destructive expansion when combined with cement containing 1 per cent alkali.

This finding was substantiated by a long series of tests made with sands from within and from without the coast area.

Effect of shale content

In the coastal area where numerous cases of excessive expansion have occurred, all but one of the commercial aggregate sources contained appreciable shale and chert percentages (see Table I). All sands with small percentages of or entirely free from shale and chert show little if any expansion in specimens as much as one year old, *regardless of the cement used.* All sands in this area that have a relatively high shale and chert content develop expansion in a few months roughly *proportional to the alkali content of the cement.* Negligible expansion occurred with

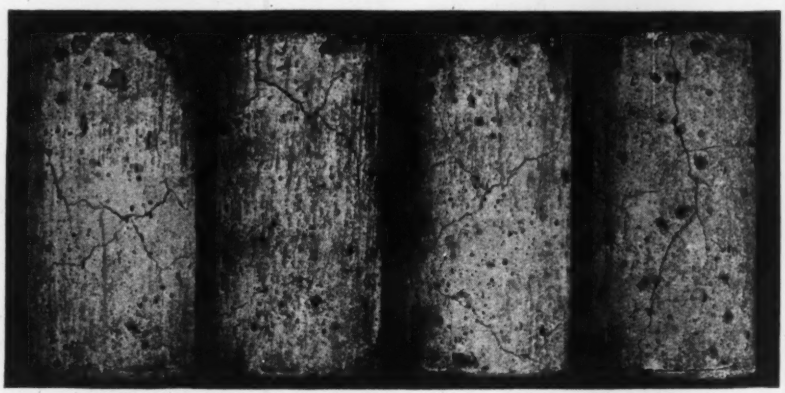


Fig. 3. Laboratory specimens of 1:2 mortar cured 7 months in sealed containers duplicating excessive expansion that occurred in the pavement. Sand contained 4.7 per cent shale and 5 per cent chert; cement had 0.98 per cent alkali.

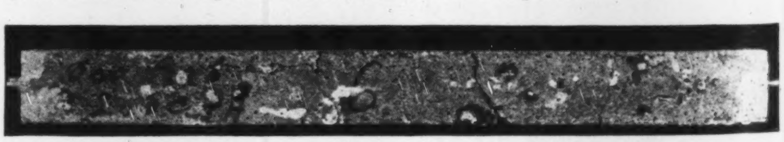


Fig. 4. This 1x1x10-in. bar of 1:3 mortar broke in handling after 11 months in a sealed container. Sand from Oro Fino Creek, cement contained 0.98 alkali, expansion was 0.32 per cent in 11 months.

cements having less than 0.5 per cent alkali and high expansion with cements having total alkali content on the order of 1 per cent. Results with cements in between these two extremes varied roughly in proportion to the alkali content (see Fig. 5).

Conclusions

It was concluded that with certain minerals, a high alkali cement may be a contributing factor to excessive expansion and subsequent failure of the concrete. Under certain conditions this expansion may not be sufficient to disrupt the structure and may cease as soon as the reaction has been completed in any particular cement-aggregate combination. In other cases, the initial cracking may not be excessive but might have very serious consequences if the structure is later subjected to action of sea water or other alkali waters. Destructive waters, seeping into the concrete, may continue the work of destruction through corrosion of reinforcing or further chemical action.

Not all the various types of chert and shale in the coastal region concerned were found to be deleterious. A study is now under way to determine which are the worst types and why. Present indications are that the worst type is a calcareous shale or impure limestone containing a comparatively high percentage of magnesia and of relatively high specific gravity (2.62 per cent), low absorption (1.7 per cent), high sodium sulphate resistance (2.8 per cent), and low rattler test loss (20 per cent). Aggregates that had contained as little as 2 per cent of this deleterious material were found to cause considerable trouble.

TABLE I—MINERALOGICAL CLASSIFICATION OF SANDS ON WHICH TEST RESULTS ARE PLOTTED IN FIGS. 5 AND 6.

Sand No.	Source	Composition Shale, Cherty-Shale, Chert and Magnesium Limestone‡
1	Monterey Co. (Oro Fino)........	8.7
2	Ventura Co. (Piru).............	9.7
3	Ventura Co. (Santa Clare River near Montalvo)...............	No Count‡‡
4	Los Angeles Co. (San Fernando Valley).......................	0.00
5	Santa Clara Co. (Coyote).......	0.80

‡ Average specific gravity of shale, cherty-shale and chert 2.3 (Range 1.90 to 2.65).

The Oro Fino, Piru and Santa Clara River sands are predominently granitic with some quartz, feldspars and sandstone; the San Fernando Valley sand is the same except that it contains few, if any, sandstone inclusions, whereas the Coyote sand is predominently sandstone with some quartz and feldspars.

‡‡ Inspection indicates as much shale and chert as Piru, if not more.

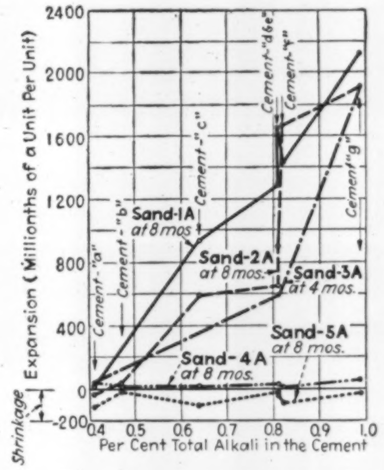


Fig. 5. Expansion of mortars cured in sealed containers increased in proportion to total alkali content (calculated as Na_2O). Results here shown were obtained with cements from seven sources and sands from five sources (Each point is the average for four specimens).

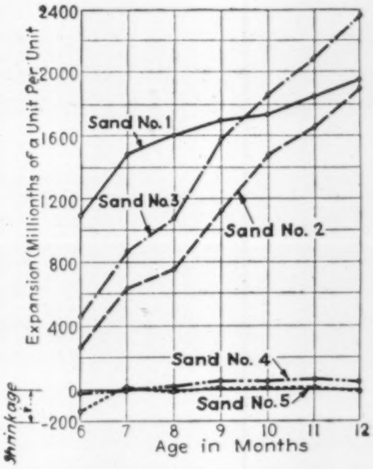


Fig. 6. Expansion of mortars cured in sealed containers increased with age when deleterious sands were used. The results here plotted are for 1:3 mortar with cement of a 0.98 per cent alkali content (Each point is the average of three specimens).

Modified specifications

As a result of these determinations, the California Division of Highways recently modified its cement specifications for use in those areas (along the coast in Monterey County south of Salinas, San Luis Obispo, Santa Barbara and Ventura counties and that portion of Los Angeles County north of the San Fernando Valley) where it is anticipated that local aggregates containing shale and chert may be used. Essentials of the specification change are as follows:

"The cement, in addition to conforming to the standard specification for moderate sulphate resisting portland cement, American Association of State Highway Officials, specification M-60-38, and the autoclave test as described above, shall not have more than 0.50 per cent total alkali when calculated as sodium oxide.

"The word alkali as used in these specifications shall be taken as the sum of the sodium oxide (Na_2O) and potassium oxide (K_2O) calculated as sodium oxide.

"The determination for total alkalis shall be made by the method as set forth in A.S.T.M. 0114-38T.

"The cement made under these specifications shall be made in a single, continuous burn, and shall in no way be polluted with cement or clinker that does not qualify under the alkali requirement.

"The bin in which cement made under this specification is stored shall be sealed on the top and bottom by the State inspector upon the completion of the grinding.

"At least one 8-lb. sample shall be taken from approximately each 300 bbl. passing on the conveyor to the bin. This shall be secured by taking the entire sample at a single operation, known as the 'grab method'. These samples shall be numbered consecutively and shall be kept separate, not being treated as a composite sample."

The investigations and test described were conducted as a research project of the California Division of Highways of which state highway engineer Chas. H. Purcell is chief.

In recording these observations and results, the author wishes to give credit to Lester Meder, assistant physical testing engineer, for having observed the accelerated expansion acting on specimens cured in sealed containers and for the subsequent direction of the casting and the measurement of test specimens; to O. J. Porter, senior physical testing engineer, and Allan Nicol, minerologist, for identification of the different mineral constituents; and to G. H. P. Lichthardt, chief chemist for direction of all chemical analyses.

A fuller paper on this subject was presented at the annual meeting of the American Society of Civil Engineers in New York in January—Editor.

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Chicago Sludge Sold

Under a 5-year contract the firm of H. J. Baker & Brothers, of Chicago and New York, distributors of fertilizer materials, will pay the Sanitary District of Chicago about $300,000 annually for sewage sludge from the Southwest and Calumet plants.

New Data on Structures and Foundations

***Contents in Brief**—From papers presented at the Am. Soc. C. E. meeting in New York two weeks ago it is noted that: Settlement of ground adjacent to excavations is inevitable but its extent can be reduced by proper construction procedure. Settlement under structures is controllable by balancing structure loads against removal of overburden. Wind force on tall buildings should be taken as 20 lb. up to 300-ft. height, increasing to 50 lb. at 1,500 ft. Continuous slabs may be designed satisfactorily by static methods.*

BUILDING FOUNDATION DESIGN

IN BUILDING CONSTRUCTION the danger of stressing soil to its limit is remote. Lateral deformation sometimes becomes important, but in general the more important element of settlement is volume decrease or consolidation of the clay. In estimating this we must ascertain the so-called preconsolidation load, that is, the maximum load to which the soil has been exposed previously in its history, frequently identical with the load of the present overburden.

Consolidation tests on undisturbed samples are expensive and time-consuming. By utilizing a discovery made by Rutledge, that the slope of the virgin compression curve of soils having the same general character follows a pattern, it is possible to correlate consolidation characteristics with the natural water content and the Atterberg liquid and plastic limits.

When excessive settlement is to be expected, the only way to reduce it is to excavate enough ground to reduce the added load, in other words by constructing a floating foundation. However, even this will not entirely eliminate settlement, partly because of the elastic swell of the soil when the excavation is made (theoretically maximum at the center of the excavation, one-half along the edges, and one-fourth at the corners), and partly because of local compression under the individual footings. Differential settlement can be counteracted, however, by building the foundation so stiff as to distribute the load.

This was done in two recent buildings in Boston, which rest on a thick substratum of soft glacial clay covered with 20 ft. of organic silt and 20 ft. of fill. In the Liberty Mutual Insurance building, 116 by 270 ft., built a few years ago, caissons were used to transfer the column loads to the hard top layer of the clay and the basement was made so deep that the weight of excavation almost equalled the weight of the building. The settlements are only a fraction of those in other buildings having similar soil conditions. Three years after construction the maximum settlement is 1.6 in.; settlement continues at the rate of only ⅛ in. per year. As an added precaution against cracking the limestone facing, the outside foundation walls were designed as reinforced girders.

At the New England Mutual Life Insurance building, 200 x 340 ft., now under construction (*ENR*, Nov. 23, 1939, p. 692), part of the site had been preloaded by two fairly heavy buildings. Explorations and soil tests proved that serious differential settlement could be avoided only by a floating foundation, which meant excavating to an average depth of 35 ft. over the entire area. The pressure along the circumferential walls was increased in relation to the interior walls, and in the corners a further increase was provided by decreasing the footing width to counteract in part the effect of the swell resulting from excavation.

The foundation walls were used as stiffening elements to reduce differential settlement, by making these walls act as concrete girders with heavy reinforcement at top and bottom.

In both the buildings mentioned, permanent benchmarks going 140 ft. deep to hard material have been established within the buildings, and many observation points have been installed to permit of frequent determination of levels. It is only by such a combination of foundation studies plus accurate observations of behavior beginning at the earliest possible date during the construction period that the many uncertainties in foundation engineering can be cleared up.—PROF. A. CASAGRANDE, *Harvard.*

WORLD'S FAIR FOUNDATIONS

Flushing Meadows, where the New York World's Fair was built, was a tidal marsh about 3 miles long north and south, with surface only 1 or 2 ft. above high tide. Since 1905 the northerly end had been used as an ash dump, and 50 million cubic yards of rubbish had accumulated. The marsh itself consisted of a deep deposit of organic silt and clay of high water content on a trough-shaped floor of sand and gravel about 70 ft. below the surface at the center of the site.

Ashes from the dump had forced their way into the marsh ground as much as 30 ft. in some places. Yet there was little preconsolidation of the marsh. Soil tests and calculations showed that settlements of over 4 ft. might be expected in places. The maximum safe load on the marsh was fixed at 300 lb. per sq.ft.

The conclusion from the explorations and soil studies was to construct the fill in a 4-ft. layer, with maximum slope of 3 per cent. Where greater thickness was required, the face of the second layer was to be kept 100 ft. back of the edge of the first. All heavy and permanent buildings were to be placed on the old fill or on a part of the site that extended into the adjacent upland, or else where they had to be placed on the marsh area (as in the case of the Trylon and Perisphere) supported on piles going down to the sand layer underlying the marsh.

No important settlements occurred during construction of the Fair buildings or during their year of service. One building experienced differential settlement amounting to nearly a foot at one group of column foundations. These columns were jacked up.—GEORGE L. FREEMAN, GEORGE W. GLICK and HAMILTON GRAY, *New York.*

WIND DESIGN PROCEDURE

In its final report, which follows six progress reports submitted in its ten years of activity, the subcommittee on wind bracing in steel buildings, consisting of C. R. Young, Clyde T. Morris, N. A. Richards and Francis P. Witmer, presented its conclusions and recommendations, of which the following is a summary:

Wind load should be assumed as a uniformly distributed force of 20 lb. per sq.ft. for the first 300 ft. above ground level, increased above this level by 2.5 lb. for each additional 100 ft. of height, no omission of wind force being permitted for the lower portions of the building by reason of alleged shelter. (See Fig. 1.)

For proportioning the wind bracing of tall buildings it is not necessary to divide the wind force into pressure and suction effects, although this should generally be done for structures with rounded roofs and for buildings with large open interiors and walls in which large openings may occur.

For plane surfaces inclined to the wind and not more than 300 ft. above the ground, the external wind force may be pressure or suction, depending on the exposure and the slope. (See Fig. 2 for values.)

For rounded roofs the wind force will depend, not only on the exposure and the ratio of rise to span, but also on whether the springings are elevated above the ground or are on the ground. For surfaces not more than 300 ft. above ground the recommended external wind force is as shown in Fig. 3 for the windward quarter and the central half of the roof arc. For the leeward quarter, for all values of the rise ratio greater than zero, a suction of 9 lb. per sq.ft. is recommended.

For a flat roof a normal external suction of not less than 12 lb. per sq.ft. should be considered as applied to the entire roof surface.

Even for buildings that are nominally airtight, internal wind forces of either pressure or suction may exist, and recommended values for various percentages of possible wall openings are given in Fig. 4.

The design wind force applied to any surface of a building should be a combination of the external and internal wind forces.

Unless the floors are adequate to serve as horizontal diaphragms for the delivery of wind load increments in each story an efficient system of horizontal bracing should be provided between the braced bents to distribute the load. Walls and partitions should be ignored in strength calculations.

Assuming effective distribution, the various braced bents may be considered as taking loads in proportion to their respective rigidities.

While shallow bracing may be of sufficient strength, it may entail excessive deflection of the building, so that for high or narrow frames it is very desirable to adopt diagonal bracing of some kind.

The portal and the simple cantilever methods are useful for making a rapid strength analysis but do not give a properly balanced design. The Cross method of moment distribution is useful for analysis but impracticable for tall frames. Both the Goldberg and the Grinter methods make it possible to effect a rapid and sufficiently accurate analysis. The method of K-percentages is recommended as a means of conducting a rapid investigation of a bent.

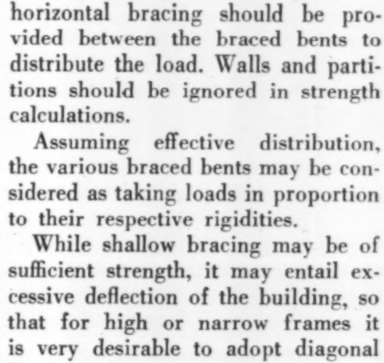


Fig. 1. Wind forces for tall buildings.

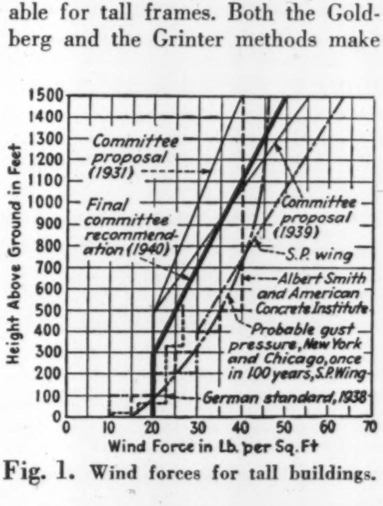


Fig. 2. Recommended force on windward slope of gable roofs.

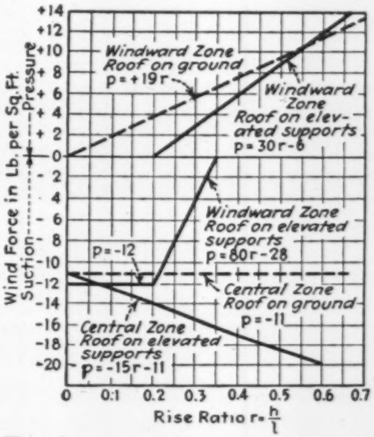


Fig. 3. Wind force on rounded roofs.

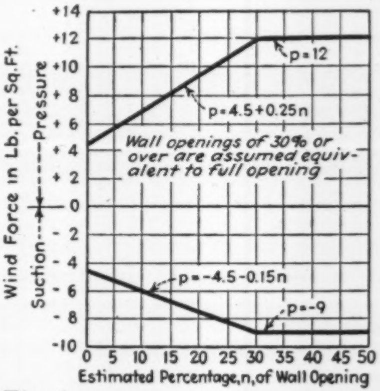


Fig. 4. Internal wind force intensity.

When the height-width ratio of a building exceeds about 5, a method of design, such as that of Spurr, which maintains planarity of floors under wind loads, should be employed. Otherwise, proper provision for secondary stresses caused by the axial deformations of the columns should be made.

Investigation of the effects of torsion should be carried out.

The maximum computed deflection of the building at the top should not exceed 0.002 of the height.

For members or details subject to wind stress only, except rivets and bolts, the permissible stress should be the same as that allowed for dead load or for dead load and live load. For members subjected to stresses arising from the combined similar action of wind and other loads, and for rivets and bolts subject to wind stress, the wind stress up to 33 1/3 per cent of the other stresses may be neglected, the excess wind stress being considered as equivalent to an added live load stress.

SETTLEMENT FROM EXCAVATION

Excavation often leads to settlement of nearby ground. Possible causes of settlement are: consolidation of the soil due to lowering of the groundwater level; removal of sand or silt by underground erosion toward the sheeting or to a sump; yield or squeeze of the soil toward the excavation. The present discussion deals with the latter cause only.

In large-scale earth pressure tests made in 1929, the author found that a very slight movement of the wall which confined the soil (less than 0.001 the height of wall) reduced the lateral pressure from its initial value of 0.60–0.70 to the minimum value corresponding to "active" earth pressure, and caused settlement of the horizontal surface of the backfill by about $0.002h$ for a distance of about $\frac{1}{2}h$ back from the wall. When the yield of the wall was increased to about $0.003h$, slip occurred in the backfill.

Since in practice the lateral yield of good timbering is seldom large enough to produce a slip, we are entitled to conclude that the settlement of the surface on both sides of a cut *in sand* is an inevitable consequence of the transition from the original state of stress in the sand to that which corresponds to the active earth pressure. This conclusion has been confirmed repeatedly by construction experience.

Small-scale tests on gelatin to find out whether a similar relation exists for very elastic, cohesive materials, showed that the settlement of the surface extends more than $2h$ from the excavation. Occurrences in construction confirm the extent of the settlement. It is not yet possible to compute the amount of settlement due to open excavation in clay and the distance to which the settlement is likely to extend. It would be very useful to make observations of settlement near open excavations in soft clay so that we may know what to expect when excavating in the vicinity of existing buildings.

In sinking foundation shafts by the Chicago method, the clay tends to squeeze into the shaft as excavation proceeds. The loss of ground due to sinking an individual shaft of small diameter is not sufficient to produce noticeable settlement but in sinking 120 caissons in a foundation through soft glacial clay to a depth ranging from 100 to 120 ft., settlements up to 0.3 ft. took place in the adjoining street surface, at a rate proportional to the progress of excavation.

This loss of ground due to bulging in foundation shafts can be reduced by (a) driving sheeting ahead of the excavation, (b) keeping the excavation filled with a heavy liquid such as clay slurry, or (c) the compressed-air caisson method.

When a tunnel is driven through soft clay, a loss of ground results from squeezing of the clay toward the working face. It may be reduced by driving temporary support ahead of the excavation (shield method), by keeping the working face under compressed air, or by a combination of the two methods.

No method is sufficient to eliminate the loss of ground entirely. During construction of the East Boston Tunnel in stiff blue clay, air pressure maintained at about hydrostatic water pressure was not sufficient to prevent settlement; the buildings on Long Wharf settled, and in the Custom House block on Long Wharf the walls cracked, in some instances from 2 to 4 in.

Similar settlement is resulting from construction of the Chicago subway on North State St. The squeeze of the ground toward the working face is measurable. An approach drift about half the height of the full tunnel was excavated without compressed air; a spearhead set 10 ft. ahead of the working face advanced toward the excavation about 2½ in. The compressed air employed during normal operation reduced the advance of the clay toward the working face of the tunnel to about 1 in. or less.

In the present state of knowledge of settlement, it happens repeatedly that the responsible engineers approve of a method of excavation and timbering without foreseeing the effect of the construction operations on adjoining buildings, and that the contractors are blamed for the damage although they executed the work according to the best of their ability. Soil mechanics helps us to evaluate the relative merits of the various methods for reducing the harmful effects but it fails to inform us on the practical consequences of several vital factors such as the details of the method of construction and the brittleness of soft clays in their original state. These consequences can only be ascertained by systematic observations in the field. —K. Terzaghi, *Harvard*.

CONCRETE SLAB DESIGN

Present experimental and analytical knowledge of reinforced concrete slabs may be summarized as follows:

A slab has somewhat more reserve strength than a concrete beam, since as an indeterminate structure it must exhaust all possible types of action before it fails. With the large deflections possible before failure it can carry part of its load by direct tension, although the amount of load so carried is not significant until the deflections approach the thickness of the slab.

At low loads, tension in concrete may make the steel stresses considerably smaller than calculated; at high loads the tension in the concrete is relatively insignificant insofar as steel stresses are concerned.

A slab will act ultimately in a manner determined by its reinforcement. In continuous slabs the relative amounts of positive and negative reinforcement can be varied considerably without affecting the strength of the structure.

Although in many common types of construction a floor slab is assumed to act in one direction only, it is unlikely that a slab would be supported and loaded so as to produce bending wholly in that one direction. Many specifications require a minimum amount of transverse reinforcement; this appears to be wise.

Theory is apparently reliable up to and beyond working loads and is on the safe side so far as ultimate strength is concerned.

We can often compute total moments on a section or on a combination of several sections, and make a reasonable assumption as to the manner in which the moments are distributed. If reinforcement is everywhere provided for the theoretical moments, in general no more steel will be required than is indicated by simplified calculations based on statical considerations only.—Prof. N. M. Newmark, *Illinois*.

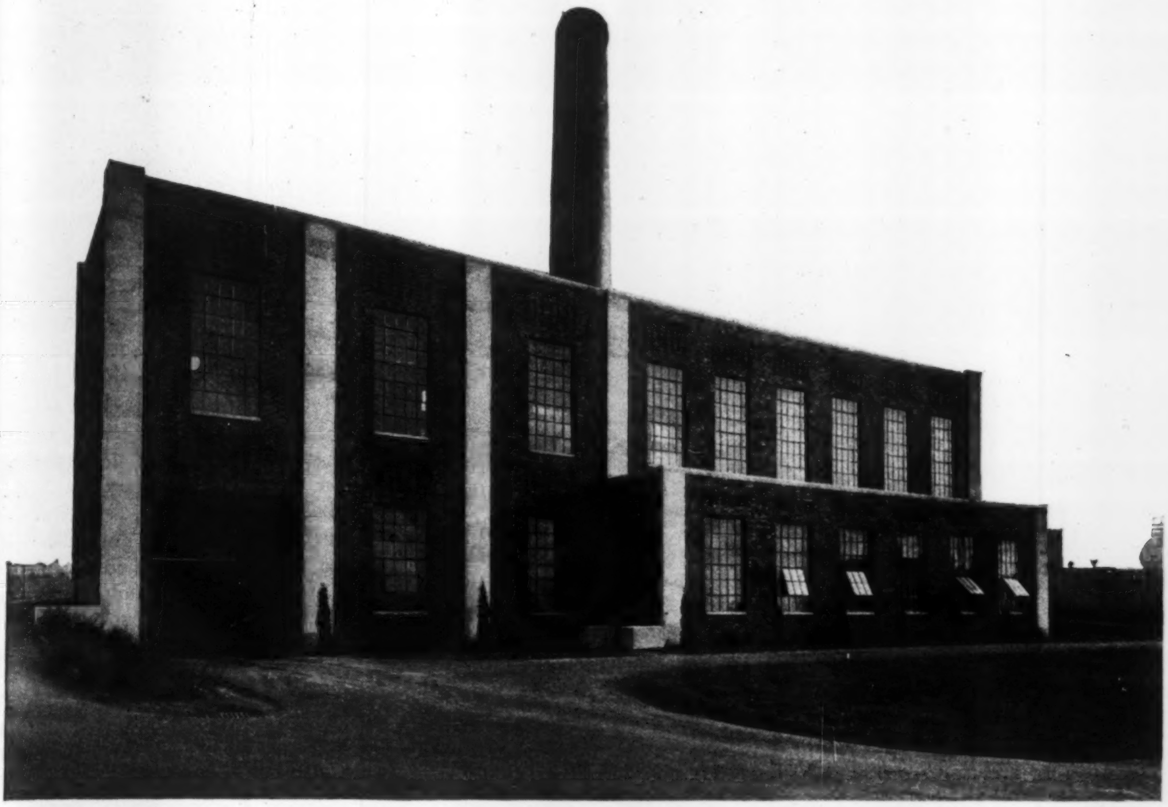


FIG. I. DESIGNED TO HOUSE AN INCINERATOR, THIS STRUCTURE AT SCHENECTADY HAS ARCHITECTURAL MERIT AS WELL.

Schenectady's Straight-Line Incinerator

***Contents in Brief**—Compactness of design is a feature of this 210-ton refuse incinerator whose layout provides straight-line movement of incoming and outgoing materials. Particularly noteworthy are the ash handling facilities and the liberal use of temperature recording equipment for operating control.*

AN INCINERATOR whose functional design and attractive architectural appearance combine to make it one of the outstanding projects of its type has just been completed in Schenectady, N. Y. Among its special features are a straight-line layout which not only contributes to operating efficiency but permitted economy in building construction as well; the use of an endless chain, steel sweep ash conveyor running through a waterseal and quenching trough to an elevated storage bin; and ground-level dumping and ash removal facilities. To assist in careful control of operation, heat recording instruments with all readings centralized on a control panel have been installed.

The designer's problem at Schenectady was: (1) To build a high-temperature refuse incinerator for a city of 100,000 population which would meet present capacity requirements of 80-110 tons a day and future needs up to 210 tons per day; (2) install the plant in an attractive building on a small site (about 260 ft. square) previously occupied by a garbage reduction plant; (3) provide a plant that would take full advantage of mechanical equipment and devices and thus reduce labor requirements to a minimum; and (4) keep within an appropriation of $165,000.

To meet these requirements Henry W. Taylor, consulting engineer for the city, laid out the building shown in Fig. 2. In it are installed two furnaces of three cells each, with duplicate appurtenant equipment for the furnaces so that they can be operated alone as individual units.

It should be noted that the building consists of a long but relatively narrow two-story central structure with a one-story wing across part of the front and back (Figs. 1 and 2). This not only permitted substantial economies by reducing the overall size of the building but it likewise permitted the use of a short-span traveling crane for handling refuse as well as a straight-line ash conveyor extending parallel to the refuse pit. Of special merit in the layout are the window facilities which provide excellent natural light from four sides for the stoking room as well as the tipping floor—an unusual but desirable provision in

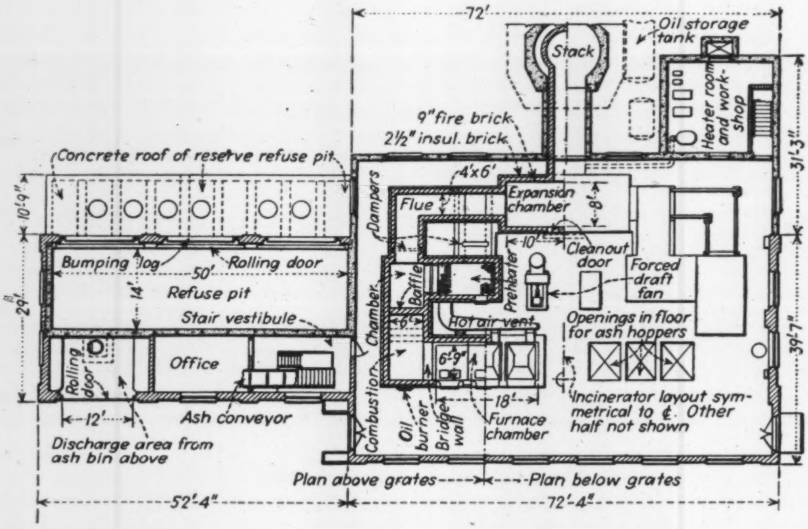

72'
Oil storage tank
Stack
Heater room and work-shop
9" fire brick
2½" insul. brick
Concrete roof of reserve refuse pit
4'x6'
Dampers
Flue
Expansion chamber
8'
10'
Cleanout door
Forced draft fan
Preheater
Baffle
Chamber
Combustion
10'-9"
29'
Bumping log
Rolling door
50'
14'
Refuse pit
Stair vestibule
6'
Hot air vent
Openings in floor for ash hoppers
Rolling door
Office
6'-9"
18'
Incinerator layout symmetrical to ℄. Other half not shown
12'
Ash conveyor
Oil burner
Bridge wall
Furnace chamber
Discharge area from ash bin above
31'-3"
39'-7"
Plan above grates
Plan below grates
52'-4"
72'-4"

Fig. 2. Careful layout of plant equipment provides a compact design.

incinerator buildings of this type.

Equipment used and its arrangement are such that only six men—three stokers, two chargers and one crane operator—are required to operate the incinerator. Simplification of operation (as well as space economy) is achieved largely through a straight-line layout in which the long axis of the ash conveyor and refuse pit are parallel to the long axis of the furnace in charging containers (Fig. 2). On the basis of the final cost, which did not exceed \$165,000, the unit cost per ton of design capacity (210 tons) was \$800.

Handling the refuse

The Schenectady installation can best be understood by considering the operation of an incinerator as involving three basic elements, namely: (1) handling the refuse; (2) burning the material; and (3) disposing of the ash residue.

Refuse brought to the incinerator in trucks is first weighed and then dumped into the storage pit at the rear of the building; this location was chosen so that the dumping operation would be out of view to traffic on the main highway passing the incinerator. The receiving bin (Fig. 2) has a storage capacity of 675 cu.yd. and trucks dump their contents from ground level into any one of three large openings. The latter can be closed off with rolling doors.

From the storage bin refuse is removed as needed and dumped into the charging hoppers which divert refuse to the charging containers located above the furnaces. A 3-ton traveling crane, equipped with a $1\frac{5}{8}$-cu. yd. clamshell bucket is used for this purpose. The charging container (Fig. 3) one for each furnace cell, holds about 1 cu.yd. of material and thus serves to limit the size of a charge; by means of a sliding door controlled by the stoker working below, a container full of material can be charged through the chute on top of the furnace into the burning chamber as needed.

The concrete walls of the storage bin (Fig. 3) are armored with 3-in. I-beams. These are set vertically on 14-in. centers, and are flush with the wall surface. Their function is to protect the walls from possible damage by the swinging bucket; the floor of the pit is similarly armored. Near the top of the inside wall of the bin inlet ducts are installed through which air and dust are drawn into the forced draft system supplying air to the furnace.

Fig. 3. How the refuse is handled: At the left the crane bucket is picking up material from the storage pit where it was dumped from trucks through the open doors; then (below) the bucket is brought up to the charging floor where it is dumped into the hoppers which empty directly into the furnaces located on the stoking floor. Note the short crane span and the low lift.

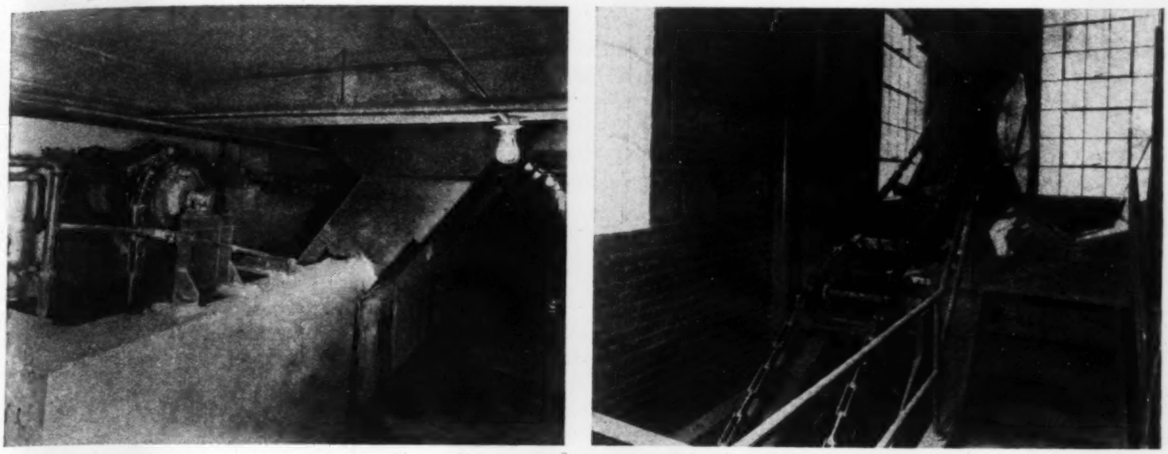


Fig. 5. **How the ash is handled: Hoppers (left) leading from each of the six furnace cells on the floor above, discharge hot ash under water into a concrete trough; a drag-flight conveyor scrapes the trough clean and elevates the material (right) to a storage bin from which it is discharged by gravity to trucks on the ground level.**

Essential equipment for high temperature incineration to insure complete destruction of combustible refuse without odor consists of a furnace chamber wherein the solid material—as differentiated from the volatile gases driven off by the heat—burns on the grate; a combustion chamber in which the combustion of volatile constituents is completed; an expansion chamber wherein the gas flow is reduced in velocity to permit the deposition of fly ash; and finally, a chimney through which the gases are dissipated to the atmosphere. Necessary adjuncts for controlling combustion are a preheater and a blower which supply the heated forced draft to the furnaces.

At Schenectady two furnace units, each with their individual combustion chambers and preheated air equipment, are provided. A common expansion chamber and chimney, however, serve both units (Fig. 2).

Each furnace, with a total grate area of 142 sq.ft. and a chamber volume of 2,100 cu. ft., is divided into three cells. The total grate area for each furnace consists of the active grate area of 95 sq. ft. plus 50 per cent for receiving area; the design basis is 0.9 sq.ft. of burning grate per ton per day. Each of the three furnace cells has individual charging containers and hoppers, dumping grates (30 in. square) and preheated air control.

The combustion chamber is baffled to assist in the mixing of gases, and it has a volume of 3,100 cu.ft. The expansion chamber has a volume of 2,520 cu.ft. The chimney has a height of 110 ft. above the grate level, and it is equipped with a heat-protective lining; a cylindrical target wall is located at the base which serves as a protective veneer for the lining at the base of the stack where greatest risk from abrasive action and slag formation occurs. The net diameter of the stack is 7.5 ft.

The preheaters, through which part of the flue gases are diverted on their way to the chimney, are of metal tube construction. Each preheater contains 160 tubes of chrome-nickel-iron composition. These tubes are 4 in. in diameter and 5 ft. long. They are held in position with top and bottom cast iron supporting plates connected with inlet and outlet chambers.

The preheaters are located at the side of the combustion chamber and are so connected that they may be entirely cut out of the system. If the inlet damper is wide open and the main damper to the expansion chamber is partly closed the major part of the hot flue gases may be diverted to pass through the preheater tubes. The latter supply 7.5 sq.ft. of surface per ton per day of rated capacity. Air from the blower fans is circulated against the outside of the tubes while the hot flue gases pass through the tubes. Each fan has a capacity of 9,000 cfm.

Since the maintenance of proper temperatures is a prerequisite to efficient, nuisance-free operation of the incinerator process, special attention was given to the installation of heat recording instruments. For this purpose thermocouples have been employed, so that the temperature can be traced in (1) the incoming air, (2) the preheated air, (3) the furnaces, (4) in two sections of the combustion chamber, (5) the expansion chamber and (6) in the base and top of the chimneys, (Fig. 4).

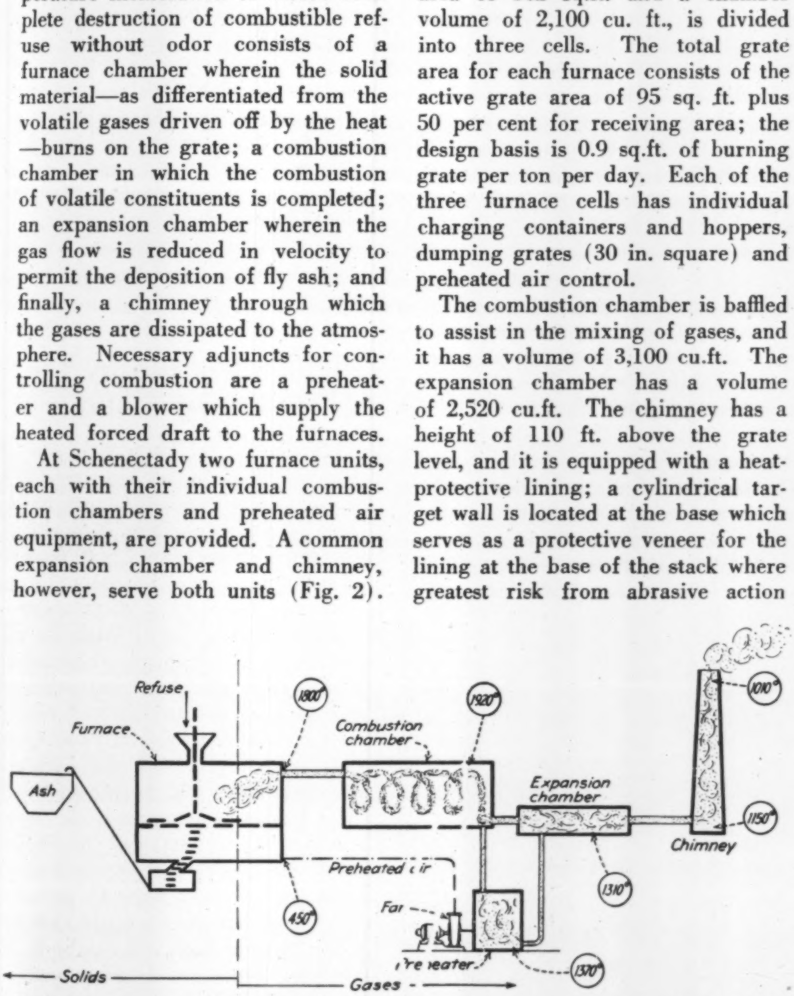


Fig. 4. **Functional diagram of the incinerator process which involves the handling of solids and gases. Temperature readings taken at critical points during routine operation are also shown.**

Readings are registered on two recording and two indicating pyrometer instruments; by means of a plug and jack switchboard arrangement, any thermocouple may be connected with any recording instrument. In the near future, draft gages will be installed so that all operations can be scientifically controlled and investigated.

Important pieces of auxiliary equipment are the oil burners, one of which is located in each of the two combustion chambers. These are used for initial warming (800 deg. temperature) of the combustion chambers, flues and chimneys when the furnaces are first started; this is done to avoid conditions which would present cold firebrick surfaces to the initial volatile gases driven off from the fuel fed in the furnace chamber and thus interfere with their complete combustion. The burners are also available for immediate use of auxiliary fuel (No. 5 fuel oil) in case of a sudden drop in temperature due to temporarily improper combustion conditions in the furnace. Thus far, the auxiliary fuel has been required only occasionally for starting and it is practically never used during burning.

Ash removal by conveyor

Ash handling—perhaps the most troublesome problem in incinerator plant operation—has been made a simple and clean operation in the Schenectady installation. The ashes are simply dumped into an ash hopper beneath the furnace (each furnace cell has an individual steel hopper located below the dumping grate) and the hopper discharges under water in a conveyor trough. Thus the ash is quenched and rendered dustless in a water-sealed pit before it is removed, by an endless chain conveyor; the latter consists of reinforced steel sweeps running on cast-iron plates at the bottom of the submerged trough as well as on the steel floor of the inclined section of the conveyor.

The conveyor elevates the ash to the charging floor elevation of the building where it discharges into a 35-cu.yd. storage bin. This bin is emptied by gravity into trucks which drive under it at ground elevation. To prevent possible freezing of the wet ash in the bin, a hot water coil has been built around the outside of the bin hopper.

Hot water for the coil as well as for heating the plant is generated by the simple expedient of circulating water through coils of pipe projecting into the expansion chamber of the incinerator. Forced circulation is provided for all circuits in the hot water system, and a 3,000-gal. tank provides storage. An auxiliary oil-fired boiler supplies hot water when the incinerator is not in operation.

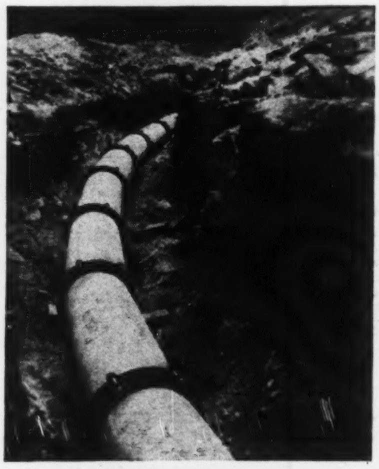
The Schenectady incinerator went into operation in October of this year and replaces a garbage reduction system used by the city in the period of 1914-33. The plant was built with the aid of PWA funds, the city contributing $85,000 to the total cost of $165,000. At present operating rates the working capacity of the plant approximates 250 tons per day, although it is rated at only 210 tons design capacity per 24 hr.

The general contract on the job was executed by George Corneau of Schenectady, and the principal subcontractor was the Hiler Construction Co. of New York. The latter installed all the equipment except the crane which was supplied by the Euclid Crane & Hoist Co. of Euclid, Ohio, the ash conveyor which was installed by the Gifford-Wood Co. of Hudson, N. Y., and the chimney which was built by the M. W. Kellogg Co. of New York City.

Henry W. Taylor, consulting engineer of New York, designed the plant. The work was done under the direction of C. A. Harrell, city manager, LeRoy C. Purdy, city engineer, and Morris M. Cohn, sanitary engineer; the latter has direct supervision of the plant.

Turn Made in Pipeline By Increasing the Joints

When asbestos-cement pipe was ordered for the new 12-in. water line for Milford, N. H., no special sections were ordered as the right-of-way for the line to the town was straight. However, after the pipe had been delivered the location was changed necessitating a wide swing in the line at the point where it leaves the reservoir. To adjust the pipe to the new location without waiting for elbows to be ordered, several standard 13-ft. lengths of the pipe were sawn into three even lengths and then were coupled with the standard flexible couplings of the type of pipe used (Century) and each joint was bent to the limit of flexibility of the coupling. In this way a 90-deg. bend having a radius of about 50 ft. was formed without resort to special sections.



Asbestos-cement pipe cut into short length and coupled with standard fixtures from a 90-deg. bend.

• • •

Windowless Factory Uses High-Level Lighting

Illumination of 20 foot-candles at the working plane has been provided in the new windowless factory building of the Simonds Saw & Steel Co., Fitchburg, Mass., by 1,500 fluorescent lamps placed in pairs 15 ft. above the floor, 14 x 20 ft. on centers. According to Gifford K. Simonds, plant manager (*Electrical World*, Dec. 16, 1939), adoption of this lighting system followed reconsideration of the original plan, made when construction of the building was begun in 1931, to use 650-watt incandescent lamp units at the same spacing. Pairs of 100-watt fluorescent units were adopted in preference to these incandescent units to give the same illumination at greatly reduced power consumption. As machines in the plant are painted bright yellow, the blue-white light of the fluorescent lamp is expected to produce "a stimulating, cheery atmosphere for the workers."

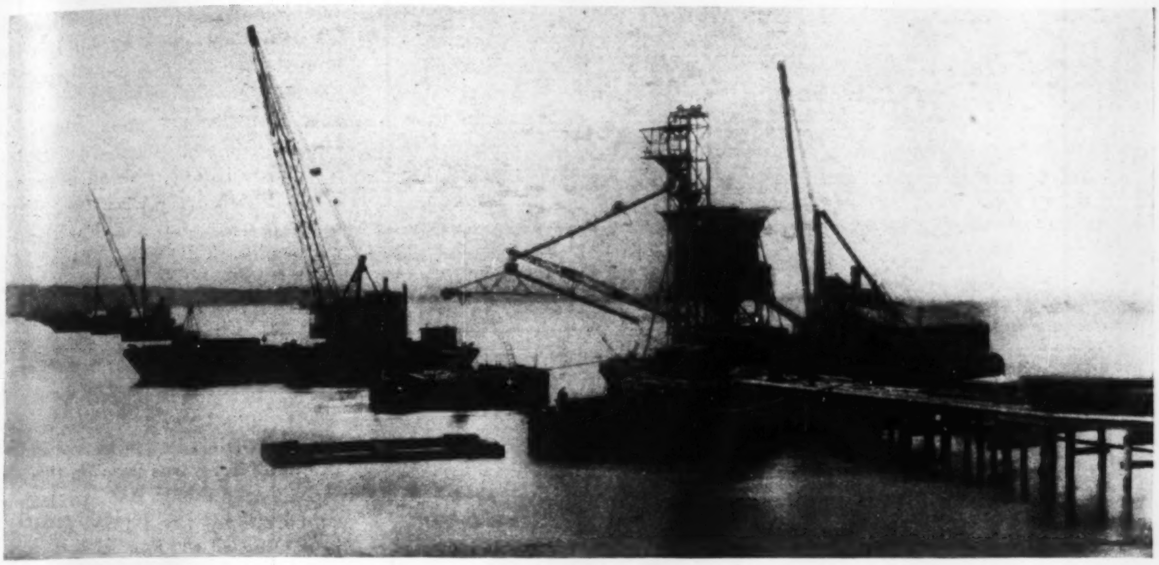


FIG. I. A WEALTH OF FLOATING EQUIPMENT SPEEDS WORK ON FIRST NARRAGANSETT BAY BRIDGE.

Substructure for Long Bridge Built in Fast Time

Contents in Brief—Sixty-nine foundations for Jamestown Bridge built in nine months. One of the largest waterborne plants ever assembled for bridge work..Twenty-nine steel sheetpile cofferdams in water from 12 to 70 ft. deep. Assembled steel bracing frames weighing up to 158 tons placed in the nine deeper cofferdams as units by derrick boat.

FACING A FAST completion schedule, the substructure contractors for the mile-and-a-quarter Jamestown Bridge over the western passage of Narragansett Bay in Rhode Island constructed nearly 70 underwater foundations in about 200 working days. For this fast work the contractors mobilized one of the largest floating construction and transport plants ever assembled for bridge construction, as indicated by the few accompanying illustrations that article space permits.

Enumerated, the substructure of the Jamestown Bridge consists of 36 concrete-pile bents, 32 concrete piers on piles or rock bottom and 2 abutments, a total length of 6,982 ft. Three piers and the abutments are on land; all the other foundations are in water comparatively shallow for the pile bents but deep enough at the piers to require substantial cofferdams. In all, cofferdams were required for 29 piers. Fig. 2 indicates the cofferdam structure which was conventional as was the design of the piers, but for nine of the piers the placing of the cofferdam bracing was a floating derrick operation of note.

Wholly a marine operation

The bridge is located just south of the well known Plum Point Light and extends from the west shore of the bay to Conanicut Island, which at this point divides Narragansett Bay into two passages. Jamestown, which gives the bridge its name, is a little community of 1,100 or 1,200 people on Conanicut Island; Newport across the eastern passage is almost directly opposite. The western passage crossed by the bridge is well over a mile of open water with a clear sweep of the wind north and south for miles. For about 2,000 ft. from the west shore the water is shallow, up to about 12 ft. deep, then it deepens to 25 ft. in about 1,800 ft. and from here to the island shore the main channel (See Fig. 3) develops to a depth of 70 ft. at about 1,800 ft. from the island.

These depth figures are set down in some detail because they had a positive influence on working conditions. With every wind there is a choppy sea and the wide sweep over open water gives almost storm proportions to north and south winds. Rainstorms often strike in squalls, and past all the pier structures the water had about a 4-mi. current pulling on floating plant and structures, straining anchor and mooring lines and testing seamanship in maneuvering and docking.

On the other hand bottom conditions are generally good. Shells and gravel, sandy clay and fine sand, offering good pile resistance, prevail to the bored depths of 60 to 70 ft. under much of the structure and to rock in the borings for channel piers. Wood test piles driven at five piers west of the channel structure showed, at depths of — 40 to — 90, no penetration or less than a foot penetration under the last 100 blows.

With these water and bottom condi-

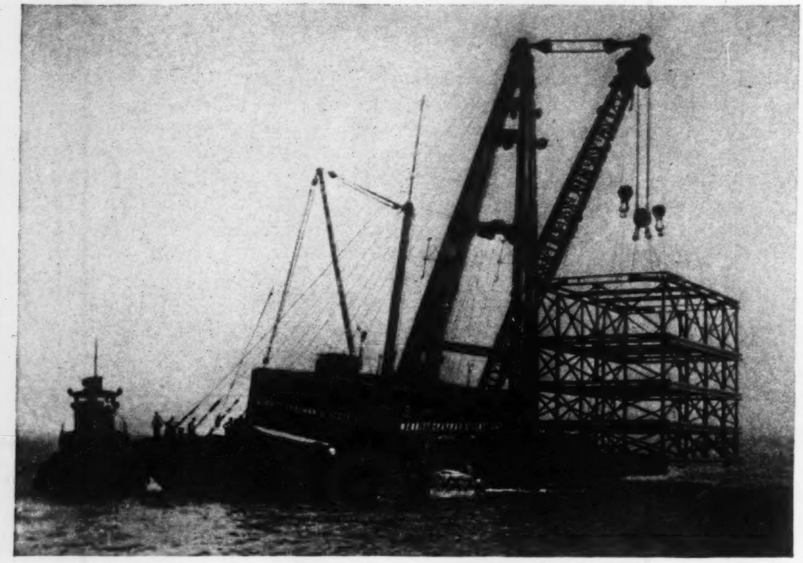


Fig. 2. **Assembled bracing frames for nine of the deeper cofferdams were placed as units by derrick boat; view shows the 158-ton frame for the deepest cofferdam being carried by the 250-ton *Monarch*.**

tions the contractors centered their operations on the use of heavy floating equipment and water transport of construction materials. Land plant was limited to moderate wharf facilities and to office, shop and service structures; no men were housed on the work.

Cement was barged from Catskill, N. Y., down the Hudson River, through Long Island Sound and up Narragansett Bay; precast concrete piles were barged from New London, Conn., and sand, crushed stone, wood piles and steel were waterborne to the site and placed in the work from the barges that delivered them. This transportation job included materials for 38,500 cu.yd. of concrete, 10,000 ft. of precast concrete piles, 110,000 ft. of wood piles, 18,000 ft. of steel H-beam piles; 2,300 tons of steel sheetpiles and 550 tons of reinforcing steel. The equipment used to place these materials in the work included two floating pile drivers, a floating concrete plant, six floating derricks besides the 250-ton *Monarch*, which was used for special work, and a score of other craft.

A novelty in cofferdamming

Interest in construction methods centers in the cofferdams for certain of the deep channel piers and particularly for the two piers for the navigation channel span. In nine of the cofferdams the steel bracing cage was assembled complete on the dock from which it was lifted, carried to and lowered into the cofferdams by the floating derrick *Monarch*. Well-known along the Atlantic coast, the *Monarch* has a lifting capacity of 254 tons.

Of the nine piers on which the *Monarch* was used, the east main span pier and three piers to the east of it were founded on rock; all others had pile foundations—in fact all of the 29 cofferdam piers except the four named had pile foundations. The deepest foundation was for the west pier of the main span. Here steel H-beam piles were driven to rock about 130 ft. deep; wood piles from 35 to 95 ft. long were used in the other pile foundations. For the west main pier, 209 89-lb., 14 x 14-in. steel H-piles 90 ft. long were driven to rock. The cofferdam for the pier masonry called for 74-ft. sheeting, the water depth being only about 40 ft. At the east main span pier the water depth was about 70 ft. but here rock was close to the bottom. Sheeting 94 ft. long was used on this pier.

Timber guide frames or templets supported by wood piles were used in driving all the cofferdam sheeting. All work was lined up from base lines on the two shores; this included the precast piles for the 36 trestle bents and in fact the lining up of piles in the bents was a more exacting task than it was to line up the cofferdams. The excellent alignment of these appears clearly in Fig. 4.

In general the procedure was this: After the sheeting was completed, the coffer was braced and mucked out by clamshell; the foundation piles were driven, the concrete seal was poured and the coffer was pumped dry. The unusual operation was, as stated before, the erection on shore of the bracing for nine of the deeper cofferdams and placing it as a unit inside the sheeting. The heavier bracing frames were of course those for the main span piers and the heaviest was for the east pier. This frame, weighing 158 tons, was 68 ft. high and 54 x 28 ft. in lateral dimensions. It is shown in Fig. 2 suspended from the boom of the derrick boat *Monarch*.

Beside the truss structure shown by Fig. 3, the bridge has eleven 100-ft. and six 80-ft. plate girder spans and

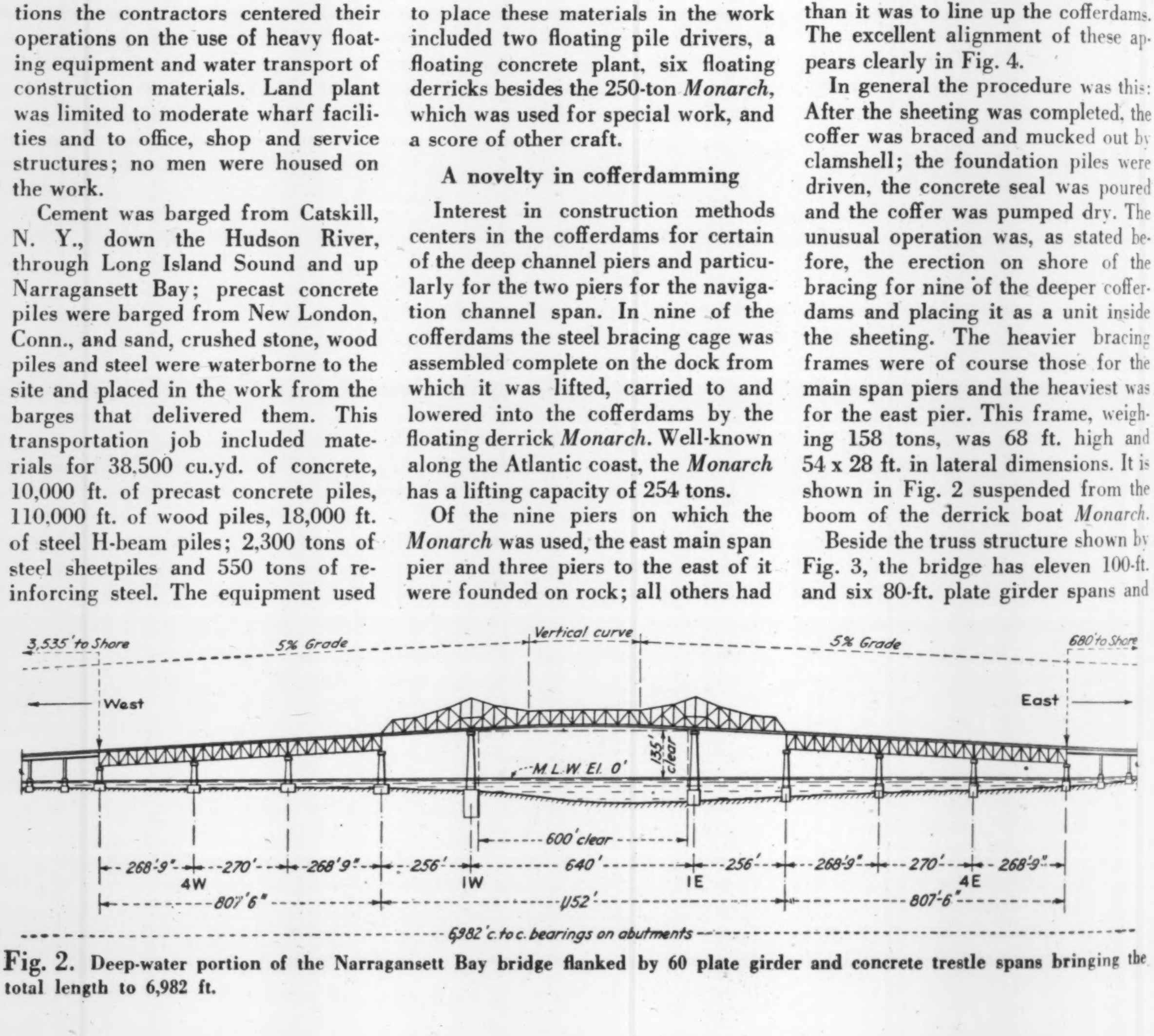


Fig. 2. **Deep-water portion of the Narragansett Bay bridge flanked by 60 plate girder and concrete trestle spans bringing the total length to 6,982 ft.**

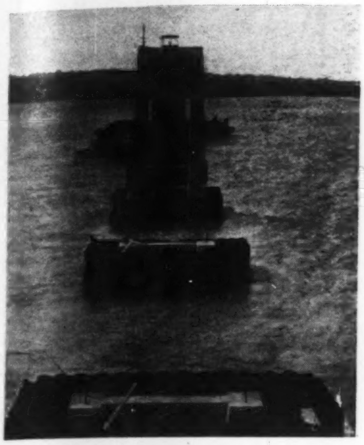


Fig. 2. **Precise alignment and shape characterized the 29 cofferdams for the 7,000-ft. Narragansett Bay bridge; the deepest dam was in 70 ft. of water.**

37 trestle spans of 55 ft. to the west shore. To the east or island end it has six 100-ft. and one 80-ft. plate girder spans. The width is 26½ ft. between trusses made up of a 22-ft. roadway and a 3½-ft. sidewalk.

Transport objectives

Jamestown Bridge is a local enterprise planned to finance itself by a toll charge. It will replace one of two ferry lines both operated by the Jamestown & Newport Ferry Co. One of these ferries is from Saunderstown on the Rhode Island mainland across the western passage of Narragansett Bay to Conanicut Island and the other is from Jamestown on the island across the eastern passage of the bay to Newport. Incidentally it is said that these ferries under some local management and with some form of water transport have been in continuous operation since 1675. The new bridge replaces the western passage ferry, but is located north of it. At present these ferries are carrying about 60,000 vehicles a year, which is not a profitable volume, but the ferries are the most direct route to Newport and the Cape Cod resort region for east and west travel on U. S. 1 and the other coast roads east from New York City. Now all this traffic as it approaches Narragansett Bay, barring that using the ferry route, has to swing north around the head of the bay at Providence and then south again. Providence is about 30 mi. north of the ferry route.

The new bridge replaces only one of the ferry lines but in the offing there is the thought that a second bridge crossing from Conanicut Island to Newport will in some way come about. However, a traffic study made by Fay, Spofford & Thorndike, consulting engineers of Boston, Mass., indicated that the present bridge by itself could anticipate a traffic of 177,000 vehicles a year for the first five years of operation. On this estimate the Jamestown Bridge Commission secured a grant from PWA of about $1,404,000 and has sold $1,700,000 in revenue bonds. The bridge is expected to cost somewhat over $3,000,000.

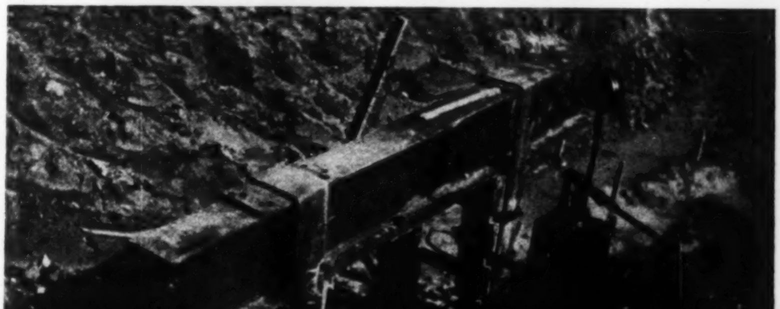
Parsons, Klapp, Brinkerhoff & Douglas, New York, are consulting engineers, with William H. Bruce as resident engineer. Tom Iverson is resident engineer inspector for PWA. The contractor for the superstructure is the Harris Structural Steel Co., New York, N. Y. The contractor for the substructure work described in this article is the Merritt-Chapman & Scott Corp., New York, N. Y., Frank W. Barnes, construction manager, Ralph De Simone, project manager, and William Denny, superintendent, are in charge of operations.

Novel Pile-Test Loading

C. G. BRODE
Company Engineer, The W. M. Brode Co.
Newcomerstown, Ohio

IN PLACE OF A WEIGHT for load tests on timber piles, the method illustrated has been successful and economical. An anchor pile with the bark on and nicked at 3-ft. intervals on four sides to increase resistance to withdrawal, is driven to refusal on each side of the test pile. The two anchor piles are cut off and an I-beam is placed across them and fastened by steel straps with tabled fish plate joints. The test pile is cut off a sufficient distance below the anchor piles to permit insertion of a jack below the beam. The load is then applied to the test pile by a hand-operated hydraulic jack. Loading on the job illustrated was carried to 60 tons without indicating any tendency for the anchor piling to lift. The two anchor piles were driven to 24 and 29-ft. penetration, respectively.

[Another scheme using a similar hydraulic jack has recently come to our attention. This utilizes the conventional weight box located over but not supported by the test pile. The hydraulic jack is used to transfer the desired portion of the weight to the pile. It appears to have merit as it allows full loading of the box at one time with subsequent application and release of partial or full load without appreciable labor.]



Hydraulic jack applies pile test load through reaction beam and anchor piles.

Large Thin-Shell Concrete Dome Dominates Montreal's Skyline

***Contents in Brief**—The dome on a new church in Montreal, built by the most up-to-date methods, takes its place in rank with the world's large domes. Pneumatically placed concrete was used in building the thin-shells, which have a thickness-diameter ratio of about 1/200. This article is abstracted from a paper by M. Cailloux presented before the Montreal Branch of the Engineering Institute of Canada and published in full in the October, 1939, issue of the* Journal *of the institute.*

THIN SHELLS of pneumatically placed concrete made it possible to built the outer dome of St. Joseph's Basilica, Montreal, to a diameter of 117 ft. 10 in. and a height of 96 ft. 3 in. above the drum. Although not quite the largest dome in the world, it is unique in the large-dome class because of the use of thin-shell construction, with its resulting economies in weight and material. Another distinction enjoyed by the church is its domination of the Montreal skyline. Its cross is 26 ft. higher than the cross atop Mount Royal.

Construction of the building began in 1924 and by 1929 the reinforced concrete frame and walls of the church were built up to the level of the side-aisle roofs. Work then ceased and was not resumed until 1937. The original plans had contemplated a structural steel frame to carry the structure above the level of the side aisle roofs. New studies, however, showed that the whole superstructure could be completed more economically in reinforced concrete. Both the inner and outer domes were designed as thin concrete shells, with no interdome framing.

Large domes have been built many times in history, but they have been extremely heavy and correspondingly thick. The dome of St. Peter's at Rome is 139 ft. in diameter and 10 ft. thick at the springing. That of Santa Maria del Fiore at Florence, also 139 ft. in diameter, has a thickness of 15 ft. at the springing, and as in St. Peter's, is divided in its upper part into two shells. The dome of St. Sophia's at Constantinople consists of a single shell with a diameter of 115 ft. and a thickness of 8 ft. at the springing. Others again, such as St. Paul's of London and the Invalides at Paris, have an interdome carrying the outer shell and lantern. The large thrusts from these heavy domes had to be resisted, as at St. Sophia's by heavy buttresses, or as at St. Paul's by chains encircling the drum; all require enormous columns for their support.

A new type of dome

The construction of the dome at St. Joseph's Basilica is entirely different. The inner and outer shells of the dome are 63 ft. 8 in. apart at their crowns, and it was desirable and economical to leave this large interdome space free. The domes themselves are thin shells of reinforced concrete, the outer 7 in. thick and the inner 5 in. thick, or about 1/200 of their inscribed diameters of 118 ft. and 88 ft. Had the domes been surfaces of revolution instead of 16-sided polygons in plan, it would have been possible to make them even thinner.

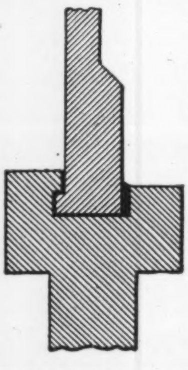


Fig. 1. Detail showing expansion joint and keying of outer dome into its supporting beams.

Since the domes are completely symmetrical, it was necessary only to design one pair of opposite faces. As the thickness of shell was too small to develop appreciable resistance to bending stresses, all bursting forces in the lower portions had to be resisted by hooping around the circumference. To this extent, the domes differ from true arches. In addition to dead load forces on both domes, wind stresses were considered on the exterior one only. The reactions of the domes are transmitted to beams spanning between the 16 trussed frames placed at the corners of the domes. These in turn rest on the eight main beams, forming the sides of two concentric squares. These beams are all 69 ft. long and 3 ft. 6 in. wide. Center depths are 24 ft. and 12 ft. in the outer and inner beams, respectively.

Provision for wind load

The dome shells each rest in a groove in the supporting beams. A lip on the inside of the dome engages a keyway cast in the beam (Fig. 1) thereby transmitting to the supporting structure any uplift from the overturning effect of the wind. Asphalt cushions in the groove seal the joints against the elements and care for some expansion and contraction. The shells of the domes themselves contain temperature reinforcing steel in both directions, close to their inner and outer surfaces. To pour the concrete successfully without an outside form, it was necessary to limit the maximum bar spacing to 4 in. Near the outer face of the shell, horizontal hoops were placed at 4-in. centers, the bar sizes being made large enough to take both the ring stresses and the bending stresses occurring in the center of each face. As it was impractical to place the hoop steel in continuous lengths, or to weld short bars together in place, continuity was provided by hooking the ends of the bars and lapping them a sufficient distance to transfer the stress through the concrete. As an additional precaution, splices were made by bolted clamps sufficient to transfer the stresses by friction on the reinforcing bars.

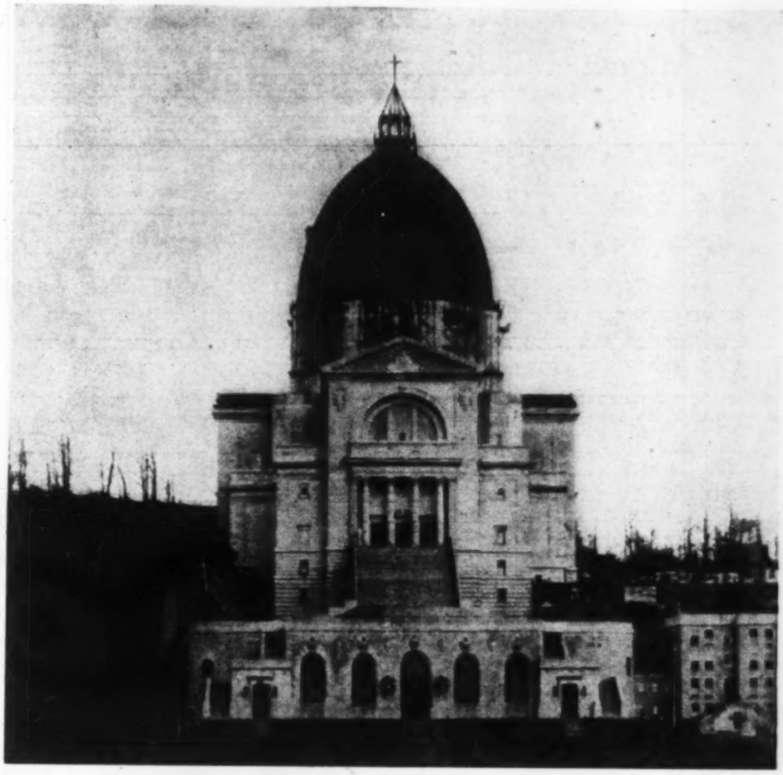


Fig. 2. St. Joseph's Basilica, Montreal. Its dome has an outside diameter of 117 ft. 10 in.

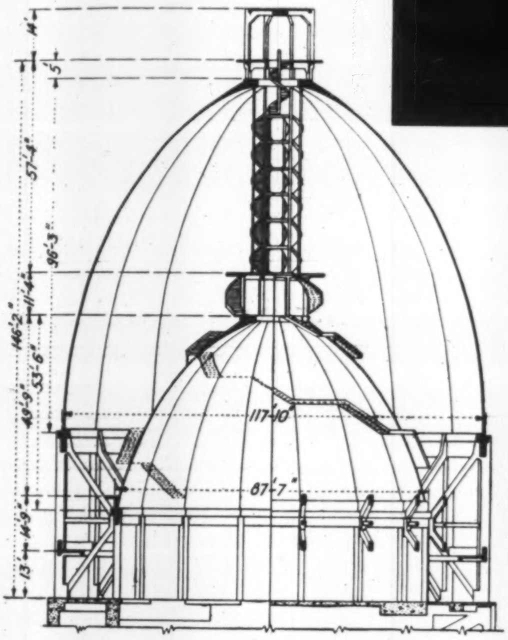


Fig. 3. Cross-section of the two domes of St. Joseph's Basilica showing the trussed frames located at the corners of the domes.

The construction of the framework supporting the domes presented no special difficulty. For the main dome, which was poured first, a tower was erected from the floor of the Basilica to carry the forms for the crown ring. From the top of this tower, 32 arched timber trusses were built, resting at their outer ends on the drum structure, one at each corner and one at the center of each face of the dome. When the trusses were placed, timber beams were set between them, on which rafters were placed, cut to fit the curve of the dome. On these rafters, cellboard planks 2½ in. thick were placed. This cellboard, designed to remain in place as the permanent insulation of the dome, was also used as the form sheathing. Before the forms were completely erected, placing of reinforcing steel was started. Notched angle spacers were used at the corners of the dome, and elsewhere the steel was supported on precast concrete blocks or steel chairs. Reinforcing bars ranged in size from ¼ to ⅝ in.

Concrete was placed by the gunite process. For the aggregates and cement, bins were constructed at a point about 220 ft. above the main floor and about 15 ft. above the platform on which the guns were placed. As this platform was built inside the dome, it was necessary to take the concreting hoses out through holes left temporarily in the formwork, and subsequently closed as the concreting progressed and the hoses were moved higher. The contractors installed four diesel-driven and one electric-driven compressors in a room on the main floor of the building. Any four of these could deliver 1,150 cfm at 60 lb. per sq.in. to a primary receiver placed on the main floor. From the primary receiver air was delivered to a second receiver, 200 ft. higher, where it was maintained at 45-lb. pressure with an output of 908 cfm. Two electric centrifugal pumps in series were used to deliver water to the nozzles at 65 lb. ped sq.in. To cope with Montreal's cold winter weather, high-early-strength cement was used, and water was heated at the guns by steam heaters to 120 deg.F. By using heated aggregates, it was possible to obtain concrete at the nozzles varying from 50 deg. to 72 deg. F., with a mean temperature of 64 deg. F. Three cement guns were kept in constant operation and a fourth was maintained as a spare.

Total quantities of material used in the domes were as follows: For the main dome, 696 cu.yd. of concrete and 58 tons of steel; for the inner dome, 250 cu.yd. of concrete and 14 tons of steel; for the lantern of the main dome, 24 cu.yd. of concrete; for the superstructure on the inner dome, 23 cu.yd. of concrete.

Associated Engineers, Ltd., of Montreal (Messrs. Cailloux, Labrecque and Papineau) were the consulting engineers for the design of the superstructure of the church and supervised its construction. Messrs. Tourville and Parent were architects. The sub-contractor for the dome construction was Gunite and Waterproofing, Ltd., Montreal.

Notes on Sewage Disposal

A monthly summary of current developments conducted by Willem Rudolfs

SOAPS AND GREASES—Recovery of soaps and greases from wool scouring liquors has been attempted for a number of years with more or less success. When fat and grease command a relatively high market price recovery is economical, at other times the prices realized do not cover the production expenses. Several processes employ chemicals, extraction and pressing. A new process where spent liquor is mixed with lime for precipitation of the soaps, and then treated with carbon dioxide, boiled, settled and filtered while the precipitate is extracted with a solvent has been described by Tupholme (*Ind. Eng. Chem., news edition,* Dec. 20, 1939).

To aid precipitation Fuller's earth or bentonite can be added or coagulents can be used such as alum, calcium or iron salts. These salts will form insoluble soaps if they are not used in excess.

Grease recovered is treated with mixtures of solvents such as acetone and ethyl acetate; acetone alone is not satisfactory because pure wool grease is not completely soluble in it. The products recovered are an alkaline earth sulfate and fatty acids. The fatty acid is changed to soap and returned for scouring in the process. This method of recovery emphasizes the re-use of waste in the process rather than recovery of by-products for sale.

TYPHOID BACTERIA—A number of studies have been published, which indicate that there may be a direct relation between the activity of bacteriophage (an agent that has the power to destroy bacteria) and reduction of pathogenic bacteria in surface waters. From tests conducted by Dinger, Marseille and Tesch (*Geneeskundig Tijdschrift Nederlandsch Indie,* Oct. 24, 1939) it appears that bacteriophage activity is not very important to the destruction of typhoid bacilli in surface waters.

Rapid destruction of these bacteria in watercourses is considered to be due to the biological action of other bacteria and protozoa. In spite of the fact that under tropical conditions typhoid bacilli disappear from river water in 8 to 12 days, the numbers remain fairly constant throughout the year. Gross and constant contamination of the surface water from soil drainage is ruled out, since the typhoid bacilli disappeared from the bottom muck as readily as from the water. The authors believe that either actual multiplication of the typhoid bacilli takes place in the water or that animals (rats, cold-blooded animals, shellfish, insects) are, in their opinion, responsible.

These assumptions raise an important question, which is of considerable interest in connection with storage of water in reservoirs, sanitation of watersheds as well as the relative potential dangers of bathing in certain surface waters containing pollution.

ENZYMES—Studies on the principles underlying the activated sludge process have been under way for more than twenty-five years and a large number of plants have been built which accomplish a high degree of treatment, but various fundamental factors are as yet not clearly established. In general there is agreement that biological processes play an important role, especially in regard to oxidation. Less agreement exists about the causes of clarification. Many investigators have assumed and mentioned that enzymes are of importance, but little work has been published to show the type and quantities of enzymes involved. Ingols (N. J. Agric. Exp. Sta. *Bull.* 669, 1939) has published results on one group of hydrolytic enzymes (trypsin, pepsin, diastase, lipase) which should give a better understanding of the enzyme factors involved. Increases in enzymes during activated sludge floc formation have been correlated with other indices of activity, and a study was made of the location of the enzymes in relation to the sludge floc and the effect of sludge concentration.

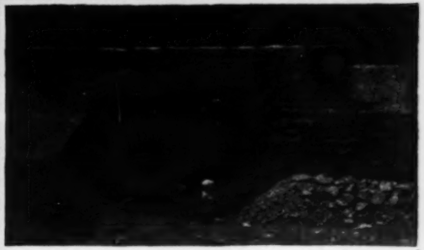
It was found that pepsin increased markedly during the development of activated sludge, while the other enzymes increased slightly. Lipase, pepsin and diastase were found only on the surface of the floc, whereas trypsin was found in the liquor. Lipase hydrolyses fats; pepsin and trypsin hydrolyse organic nitrogenous material such as protein; and diastase operates on carbohydrates such as starch. Mr. Ingols concludes that the clarification of sewage is the result of the bio-physical properties of the sludge. Factors like return sludge concentration, strength of sewage, type of food are important in operation. The removal of turbidity is caused by the physical condition of the sludge, while the removal of food is controlled by the enzyme activity.

TEXTILE WASTES—The application of biological processes in textile waste purification has been under study for many years. The most effective method of providing contact of air and waste, necessary for aerobic action, is by means of bio-aeration, intermittent sand filtration or trickling filters. An undiluted textile waste cannot be applied directly to an intermittent sand filter at the usual rates without clogging. Filters of sand or coke breeze discharge an effluent with a decreased oxygen demand, but the organic matter remains practically unchanged in the filter. Hoover (*Ind. Eng. Chem.* 31, 1352, 1939) gives the following figures to show the straining or screening action from 4-ft. depth filters of coke breeze, bituminous steam coal and coal ash of approximately equal sizes:

Percent reduction in oxygen consumed:	Coke Breeze	Coal ash	Steam coal
500 gal. cu. yd./day	48–82	37–77	52–84
1,000 gal. cu. yd./day	34–79	30–79	42–77
2,100 gal. cu. yd./day	22–64	19–58	19–55
Aver. capacity to clogging gal./cu. yd. . .	26.210	29.610	12.780
Aver. oxidizable matter removed lb./cu. yd.	18	17	5.2

There is no indication of nitrification in these filters and no difference occurred when filters were completely covered. It seems evident that these filters perform the functions of straining devices (screening) and must be cleaned from time to time. More and more automatic sand and coke cleaning devices are being tried out for textile waste treatment.

Build Beauty INTO SMALL BRIDGES



(Top:) *TURNING AN EYESORE INTO A BEAUTY SPOT. Steel arches for small bridges like this can be bolted together in a day with U·S·S Sectional Plates at a great saving in time and labor costs.*

(Above and left:) *HIGHWAYS LOOK LIKE PARKWAYS when beautiful arch bridges are used. U·S·S Sectional Plates make possible beauty without sacrifice of strength or low cost.*

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THERE'S no reason why small bridges should not be beautiful when they are so easy to build with U·S·S Sectional Plates. Graceful arches can be quickly bolted together by ordinary labor crews.

Expensive forms are not required. U·S·S Sectional Plates fit together firmly. The base metal is U·S·S Copper Steel, which has double resistance to atmospheric corrosion. In addition, a heavy coating of galvanizing is applied to furnish extra protection against rust.

The adaptability of U·S·S Sectional Plates makes them suitable for culverts, sewers, conduits, or the enclosing of small streams.

Write to any of the companies listed below for complete information on how to save time and money with this new type of construction.

SECTIONAL PLATES

CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*

Scully Steel Products Company, Chicago, *Warehouse Distributors* · United States Steel Export Company, New York

UNITED STATES STEEL

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

SEPULVEDA DAM CALIFORNIA

OWNER: U. S. Engineer Office, Los Angeles, Calif. Lt. Col. Edwin C. Kelton, district engineer.

PROJECT: Construction of rolled earth-fill Sepulveda Dam on Los Angeles River, northwest of intersection of Ventura and Sepulveda Blvds., in the city of Los Angeles. Consists of dam and appurtenant works including the subgrade for the realignment of the Southern Pacific Railroad. Crest length at top elevation approximately 15,500 ft. Maximum height above valley floor 50 ft. Top width 30 ft. Rock toes constructed and rock paving on upstream slope. Spillway and outlet works located about midway along dam. Outlet works consist of combination of ungated and gated openings controlled by operating equipment in control house above gate chamber. Spillway, supported on steel bearing piles, consists of gravity overflow section with variable crest elevation. Contractor also required to construct Encino Levee.

CONDITIONS: Government to furnish cement, service gates and crest gates. Contractor to furnish and install balance of material and complete project in 500 to 720 days contingent upon acquisition of rights-of-way. Job is easily accessible and rail and highway transportation facilities available. Wage rates are: skilled, $1.50 per hr.; semi-skilled, $1.00; and common labor, 62½c. per hr.

BIDS: Eleven bids were received December 21, 1939, ranging from the contract low of $3,121,268 to $3,934,505. Engineer's estimate $3,950,000.

LOW BIDDERS:

1. Jahn-Bressi-Bevanda Constructors, Inc., David C. Gordon and Joseph A. Dowling, Los Angeles, Calif. (contract)	$3,121,268
2. J. F. Shea Co., Inc., and MacDonald & Kahn, Inc., Los Angeles and San Francisco, Calif.	3,289,530
3. Morrison-Knudsen Co., Los Angeles, Calif.	3,377,716

Item	Unit	Unit Prices		
		(1)	(2)	(3)
1. Remove exist. struct	L. S.	$4,200.00	$3,000.00	$9,000.00
2. Clear and grub	L. S.	9,500.00	5,000.00	10,000.00
3. Stripping topsoil	35,000 c. y.	.12	.20	.105
4. Stripping, for embankmt	230,000 c. y.	.10	.20	.12
5. Common excav. (uncl.)	2,070,000 c. y.	.13	.17	.175
6. Structure excav. (uncl.)	8,500 c. y.	.90	.75	1.50
7. Excav. borrow, incl. haul	1,630,000 c. y.	.14	.16	.14
8. Railroad subgrade excav. (uncl.)	11,000 c. y.	.25	.25	.20
9. Railroad subgrade, grading borrow	108,000 c. y.	.25	.20	.18
10. Steel brg. piles, vertical	69,000 l. f.	2.20	1.80	2.15
11. Steel brg. piles, batter	74,000 l. f.	2.30	1.85	2.25
12. Splice steel brg. piles	1,500 l. f.	2.00	11.00	4.40
13. Steel brg. pile caps	2,750 ea.	3.00	5.00	4.00
14. St. sheet piling, 2 types	119,000 s. f.	1.55	1.20	1.45
15. Steel sheet piling, 22-lb./s. f	12,000 s. f.	1.00	1.10	1.15
16. Struct. backfill, uncompacted	55,000 c. y.	.10	.20	.15
17. Struct. backfill, compacted	5,000 c. y.	.70	1.00	.55
18. Fill in embank., dam	2,400,000 c. y.	.05	.055	.06
19. Fill in embank., levees	30,000 c. y.	.07	.08	.08
20. Spread and grade topsoil	31,000 c. y.	.40	.25	.10
21. Roll, for add'l. 2 trips	5,600,000 sq.	.005	.006	.005
22. Rock fill in toes	74,000 c. y.	2.20	1.90	2.00
23. Grout. rock toes, slope paving	15,100 c. y.	2.70	2.80	2.80
24. Rock fill below spillway, cutoff	62,000 c. y.	2.25	2.65	3.50
25. Rock paving, ungrouted	12,350 sq.	21.50	24.00	24.00
26. Rock paving, grouted	5,650 sq.	24.50	28.00	30.00
27. Gutter paving	6 sq.	20.00	30.00	30.00
28. Gravel and surfacing	54,800 s. y.	.35	.40	.31
29. Asphaltic conc. pavement	1,800 s. y.	1.00	1.00	1.20
30. Sand and grav. filters, drains	42,000 c. y.	1.60	1.25	1.30
31. Gravel backing	55,000 c. y.	1.25	1.25	1.25
32. 4-in. vitr. clay pipe	250 l. f.	.30	.40	.40
33. 4-in. tile drains	325 l. f.	.20	.25	.30
34. 8-in. tile drains	6,900 l. f.	.40	.50	.45
35. 12-in. tile drains	5,000 l. f.	.60	.60	.70
36. 18-in. tile drains	85 l. f.	1.50	1.50	2.00
37. 24-in. tile drains	500 l. f.	2.50	2.60	3.20
38. Sub-drain risers and hoods	8 ea.	90.00	60.00	90.00
39. Cl. A conc., slabs and wall ftgs	33,000 c. y.	4.00	4.00	4.65
40. Cl. A conc., spillway ogee, pier	15,300 c. y.	7.30	9.00	6.40
41. Cl. A conc., control wks., struct	16,800 c. y.	11.00	11.15	10.50
42. Cl. A conc., spil. br. superstr	640 c. y.	25.00	20.00	26.00
43. Conc. serv. gate recesses	440 c. y.	10.00	30.00	10.00
44. Pres. grout serv. gate castings	L. S.	1,200.00	250.00	400.00
45. Conc. crest gates, oper. equip. recess	70 c. y.	30.00	30.00	30.00
46. Grouting wells	2,000 c. f.	.60	1.00	.60
47. Grouting rock fills	3,600 c. y.	4.50	4.00	4.00
48. Reinforcing steel	7,500,000 lb.	.035	.04	.038
49. Rubber joint seal	10,400 l. f.	3.50	4.00	4.30
50. Rubber joint seal, std. cross #1	49 ea.	15.00	20.00	20.00
51. As above, std. elbow, #2	7 ea.	10.00	15.00	15.00
52. As above, std. tee #3	49 ea.	10.00	15.00	14.00
53. As above, spec. tee #4	59 ea.	6.00	10.00	11.00
54. As above, spec. ring conn. #5	4 ea.	25.00	30.00	33.00
55. ½-in. fibre expan. joint filler	24,200 s. f.	.09	.10	.35
56. ¾-in. fibre expan. joint filler	20,500 s. f.	.12	.15	.38
57. ¼-in. cork exp. joint filler	3,000 s. f.	.25	.25	.50
58. 2-in. cork exp. joint filler	550 s. f.	1.40	1.30	1.80
59. Inst. serv. gates and accessories	465,000 lb.	.025	.0155	.025
60. Inst. crest gates	1,000,000 lb.	.025	.025	.031
61. Inst. control valves and oper. equip. (20-in.)	60,000 lb.	.05	.05	.027
62. ¾-in. hose bibbs	8 ea.	2.00	1.00	1.50
63. 1¼-in. 125-lb. angle valves	8 ea.	4.00	4.00	3.50
64. 3-in. 125-lb. gate valve	7 ea.	25.00	25.00	25.00
65. 4-in. 125-lb. gate valve	7 ea.	35.00	35.00	33.00
66. 5-in. 125-lb. gate valve	7 ea.	50.00	45.00	60.00
67. 8-in. 125-lb. gate valve	8 ea.	60.00	60.00	60.00
68. 18-in. 100-lb gate valve	7 ea.	300.00	310.00	280.00
69. 20-in. 100-lb. gate valve	7 ea.	400.00	350.00	340.00
70. Valve floor stands	21 ea.	100.00	33.00	42.00
71. 6-in. 125-lb. expansion joints	14 ea.	125.00	95.00	80.00
72. Misc. iron castings	6,200 lb.	.15	.15	.16
73. 1¼-in. wr. iron pipe and fittings	20 l. f.	1.00	2.00	.75
74. 3-in. wr. iron pipe and fittings	350 l. f.	2.00	2.50	1.20
75. 4-in. wr. iron pipe and fittings	280 l. f.	3.00	3.00	2.00
76. 5-in. wr. iron pipe and fittings	90 l. f.	4.00	4.00	3.00
77. 6-in. wr. iron pipe and fittings	1,380 l. f.	3.00	2.90	2.30
78. 8-in. wr. iron pipe and fittings	1,040 l. f.	4.00	3.25	3.00
79. Water pressure regulator	1 ea.	50.00	31.00	35.00
80. 4-in. cast iron soil pipe	100 l. f.	1.50	1.25	.75
81. Misc. black steel pipe	11,800 lb.	.10	.07	.12
82. Misc. galv. steel pipe	4,000 lb.	.15	.15	.18
83. Oil pressure system	4,000 lb.	1.00	.65	.50
84. Furn. oil and fill oil system	1,000 gal.	.50	.40	.55
85. Oil pumping units	2 ea.	750.00	700.00	900.00
86. Stand-by unit	L. S.	5,000.00	4,800.00	5,000.00
87. Switchboard	L. S.	2,000.00	2,600.00	2,535.00
88. Traveling crane	L. S.	5,000.00	5,200.00	5,600.00
89. Gate position indicators	L. S.	1,500.00	1,200.00	1,120.00
90. Conduit for electric wiring	9,600 lb.	.40	.30	.35
91. Lighting and power system	L. S.	5,000.00	7,000.00	5,500.00
92. Underground power service	L. S.	2,500.00	2,700.00	2,700.00
93. Str. steel in trash racks, crane girders, rail grillage	197,000 lb.	.10	.072	.08
94. Misc. metalwork	145,000 lb.	.12	.11	.14
95. Misc. brass and bronze	120 lb.	1.00	1.00	.80
96. Misc. steel tubing handrail	1,150 lb.	.70	.40	.30
97. Bridge railing	1,175 l. f.	5.00	3.60	4.00
98. Channel fencing	6,600 l. f.	.50	.33	.30
99. Highway guard post and rail	1.2 Mbm	150.00	100.00	160.00
100. Plant-mixed surfacing	4,200 s. y.	.40	.30	.70
101. Control house superstr	L. S.	10,000.00	10,200.00	9,000.00
102. 24x24-in. autom. drainage gate	1 ea.	100.00	100.00	120.00
103. 24-in. corr. met. pipe	40 l. f.	3.00	3.00	3.75
104. 36-in. corr. met. pipe	440 l. f.	7.00	6.50	8.50

BRIDGE, MAINE

OWNER: Maine State Highway Commission, L. D. Barrows, chief engineer, Augusta, Me.

PROJECT: Steel superstructure for through truss steel bridge over East Branch of Penobscot River, Medway, Me. Consists of three spans 140-ft., 225-ft., and 140-ft. long, respectively. Roadway 24-ft. wide; two 2-ft. sidewalks. Skew, 34 deg. 10 min.

CONDITIONS: Material to be furnished by contractor, who must complete work not later than May 15, 1940. Rail transportation available. Prevailing rate for structural ironworkers in Portland, Me., is $1.25 per hr.

BIDS: Six bids were opened Nov. 22, 1939, ranging from the contract low of $68,343 to $74,655.

LOW BIDDERS:

1. Phoenix Bridge Co., New York, N. Y.	$68.343
2. American Bridge Co., Boston, Mass.	71.401
3. Bethlehem Steel Co., Bethlehem, Pa.	71.677

Item	Quan.	Unit Prices		
		(1)	(2)	(3)
1. Struct. steel, riveted, del	961,600 lb.	$0.0524	$0.054	$0.0532
2. Erection, struct. steel	950,000 lb.	.0189	.0205	.021

"No Spares

WHEN YOU USE 'INCOR'," —SAY E. A. WHITNEY & SON

IN the old days, before 'Incor', E. A. Whitney & Son, Kansas City, Mo., piling contractors, used to precast 5 to 10 extra piles for every job—"spares" that came in handy in case of breakage. But experience with 'Incor' quickly proved that, as Mr. Whitney puts it, "you don't need any spares when you cast piles with 'Incor'."

On Kansas City, Kan., Market and Food Terminal (J. A. Tobin Construction Co., general contractor), 1264 33-foot 'Incor' piles were driven 3 to 5 days after casting, without fracture or loss of a single pile. Piles were driven by a No. 1 Vulcan hammer, using a 5000-lb. ram, requiring 34 to 36 blows per foot.

'Incor' cures or hardens in one-fifth the usual time. In precast products, that means savings through faster use of pallets or forms, reduced stock-pile requirements, faster capital turnover. In building construction, 'Incor' cuts heat-protection expense... saves money through reduced form costs and lower job overhead, too.

Use 'Incor'* wherever dependable high early strength or faster job curing shows a net profit; elsewhere, use Lone Star, the quality standard ever since 1900. Write for copy of "Cutting Concrete Costs." Lone Star Cement Corporation, Room 2288, 342 Madison Avenue, New York. *Reg. U. S. Pat. Off.

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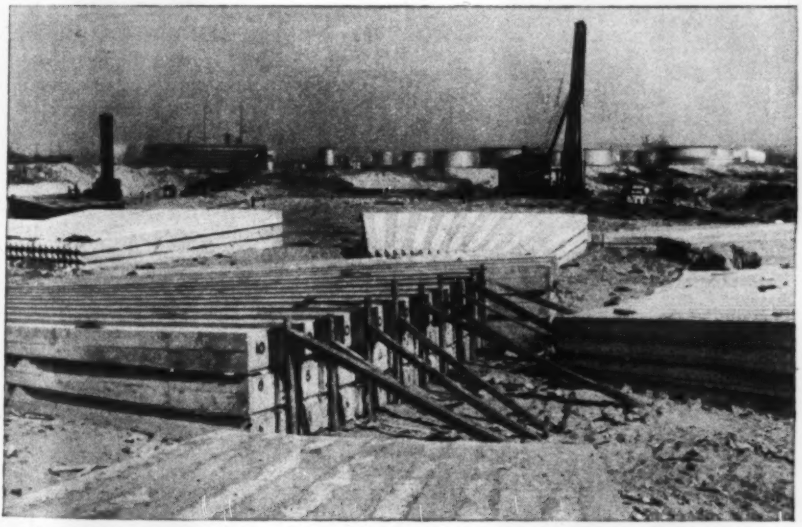
Sales Offices: ALBANY, BIRMINGHAM, BOSTON, CHICAGO, DALLAS, HOUSTON, INDIANAPOLIS, JACKSON, MISS.; KANSAS CITY, NEW ORLEANS, NEW YORK, NORFOLK, PHILADELPHIA, ST. LOUIS, WASHINGTON, D. C.



(Above) 'Incor' can take it! 33-ft. 'Incor' pile being swung into position for driving by No. 1 Vulcan hammer, using 5000-lb. ram; 34-36 blows required per foot; at Kansas City, Kan., Market and Food Terminal project. (Left) 1264 'Incor' piles precast and driven without fracture or loss of a single pile. Contractor didn't make any "spares," knew that with 'Incor' he'd have no need for them.

LONE STAR CEMENT CORPORATION

MAKERS OF LONE STAR CEMENT · · · 'INCOR' 24-HOUR CEMENT

gold digger

MODEL 350 . . . . Half Yard
AMERICAN GOPHER dragline

digs gold from ancient stream bed against back drop of beautiful pine clad hills. But the beauties of nature are not what interests the owners of the placer gold working in Lake Gulch, near Delta, Idaho. Speedy, economical removal of heavy overburden and snappy handling of pay dirt to the hopper washer is their look-out — and it is what they get from their AMERICAN GOPHER Dragline. They say that it handles 500 yards per 8-hour shift and that "It has never caused us a minute's delay yet." That IS important.

SEVEN MODELS: 350 — ½-yd.; 375 — ¾-yd.; 400 — 1-yd.; 425 — 1¼-yd.; 450 — 1½-yd.; 475 — 1¾-yd.; 500 — 2-yds.

Gas, Diesel or Electric. Shovel quickly convertible to Crane Dragline or Clamshell.

Write for descriptive literature.

AMERICAN HOIST & DERRICK CO.
NEW YORK SAINT PAUL, MINNESOTA CHICAGO
AMERICAN TERRY DERRICK CO.
SOUTH KEARNY, N. J.

STANDARDIZE on the Genuine CROSBY CLIP for Safety
PERFECT GRIP DROP FORGED STEEL HOT GALVANIZED

INSIST ON THE RED U-BOLT
safe since 1883

MEN AND JOBS

William Kantola is city engineer of Conneaut, Ohio and not Ashtabula, as reported in a recent issue. **C. R. Stanhope** is city engineer of Ashtabula.

Webster L. Benham, civil engineer of Oklahoma City, has resumed his consulting practice with offices in Oklahoma City. Previously he was in charge of the Oklahoma Concrete Pipe Association, a firm which has now been dissolved. Also for a time he was director of operations and chief engineer for the WPA at Oklahoma City.

Herbert F. Wickenkamp, engineer of Audubon County, Iowa, for the past year, has been reemployed for another two years and will be stationed at Audubon.

Homer R. Seely, deputy commissioner of public works, New York City, has been appointed a member of the American Institute of Steel Construction jury to select the prize winning designs in the students annual bridge design competition. Other members of the jury are: **W. Earle Andrews**, consulting engineer; **Frederick C. Hirons**, architect; **Alfred Easton Poor**, architect, and **Kenneth Reid**, editor of *Pencil Points*, all of New York City. The design has been held annually during the past 11 years. First prize is $200 and second and third $100 and $50 respectively.

George F. Prong, active in city planning for a number of years for the Chamber of Commerce, Buffalo, N. Y., has been appointed executive secretary of the Niagara Frontier Builders Association. He also formerly was associated with the Niagara Frontier Planning Board and the former city planning committee.

Hal F. Smith, superintendent of customers accounts and collections, Detroit Board of Water Commissioners, March 1, will become senior administration assistant, succeeding **Daniel C. Grobbel**, who retires on that date. Smith, who has been with the water board since 1918, has been a leading spirit in the financing and accounting division of the American Water Works Association since its formation.

J. John Miller, Pittston, Pa., has been appointed assistant engineer in the Pennsylvania Department of Health.

Ralph Follett has been appointed engineer of Wahkiakum County, Wash.,

(Continued on p. 88)

What comes under the head of

LEAKAGE?

e answer is *leakage*—nothing else. *Not* water used by the fire department and the sewer depart-
nt, nor water for street flushing, main flushing, fountains and public buildings. These and other
s and losses properly come under the head of *unaccounted-for water,* estimated to total about
% *of normal consumption.* Some —
t all — is due to leakage from mains.

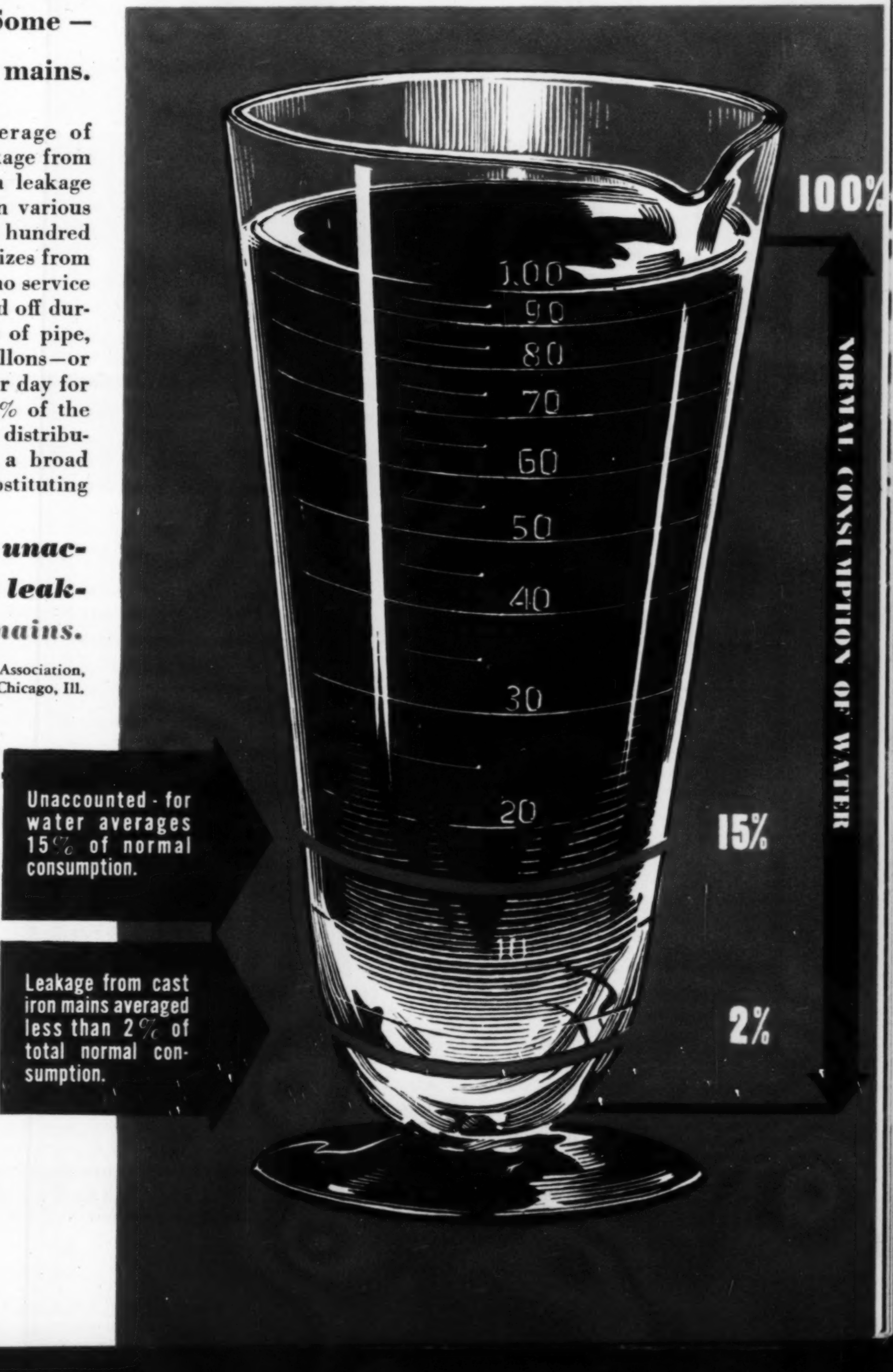
* * * *

ascertain how much of the 15% average of
ccounted-for water is actually due to leakage from
er mains, we have recently conducted a leakage
survey of cast iron mains in 25 cities in various
es. The mains tested range from several hundred
t to more than twenty miles in length, in sizes from
o 30" and up to 44 years old, either with no service
nections or relatively few that were turned off dur-
the tests. The average leakage per mile of pipe,
inch of diameter, per 24 hours was 41 gallons—or
average of 380 gallons per mile of pipe per day for
sizes tested. This leakage is less than 2% of the
rage of normal consumption per mile of distribu-
main per day. This survey, covering a broad
rage of water main construction and substituting
s for guesswork, shows that

s than one-tenth of all unac-
unted-for water is due to leak-
e from cast iron water mains.

further information write to The Cast Iron Pipe Research Association,
as F. Wolfe, Research Engineer, 1015 Peoples Gas Bldg., Chicago, Ill.

Look for the "Q-Check" registered trade mark. Cast iron pipe is made in diameters from 1¼ to 84 inches.



Unaccounted-for water averages 15% of normal consumption.

Leakage from cast iron mains averaged less than 2% of total normal consumption.

gold digger

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AMERICAN GOPHER dragline

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TIGH

BOU

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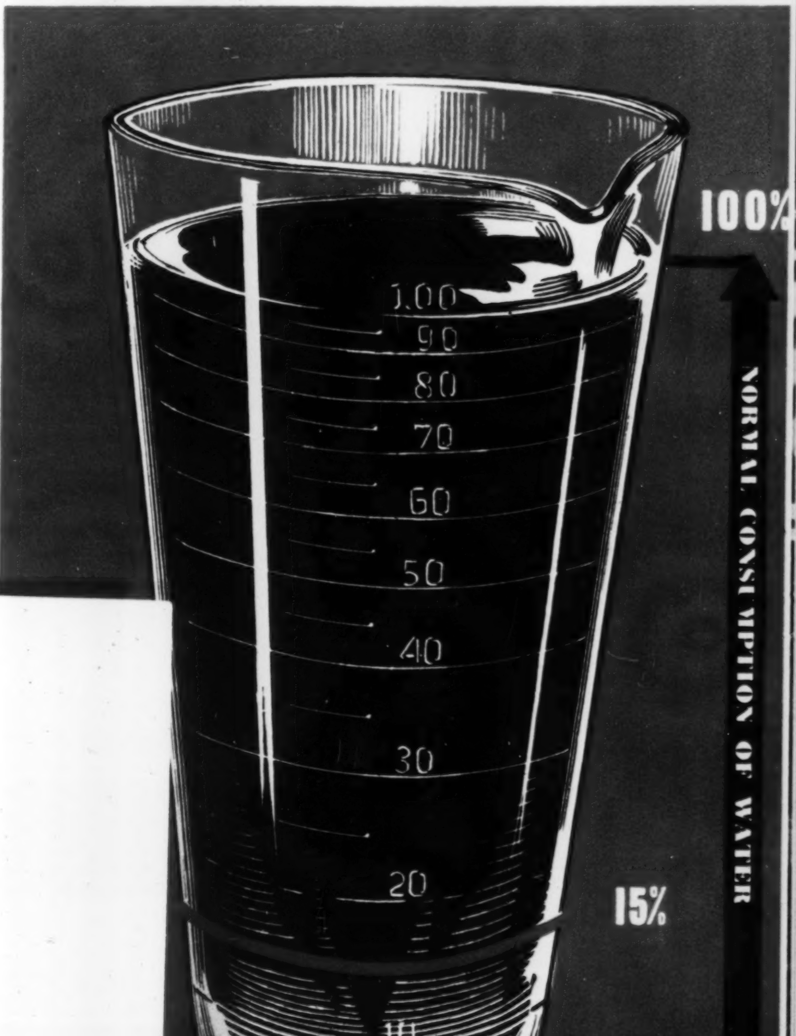

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MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

FEBRUARY construction material prices are remarkably close to January levels. Only minor changes in the *ENR* 20-cities are reported. Short Leaf Yellow Pine is up $1.00 on most sizes in Atlanta; off $1.00 on 1-in. and 2 x 4- and 2 x 6-in. sizes in Cleveland; and off 50c. on 1-in. boards in St. Louis. Douglas Fir prices are up 50c. and $1.00 on most 1- and 2-in. sizes in San Francisco; but are $1.00 lower on the 2 x 4-in. size in Chicago.

Granite paving brick is $5.00 per M higher in Boston, but off $2.00 in Atlanta. Brick paving blocks are down $4.50 per M in Pittsburgh.

Structural steel shapes are 15c. per 100 lb. lower in Boston, and 65c. lower in San Francisco. Expanded metal lath prices are higher in St. Louis, but off in San Francisco.

Skilled and common labor rates in the 20 cities remain unchanged from January. As a result of an agreement between unions and employers, the current rate for common labor on heavy construction in New York has been fixed for the next three years. In the event of any unusual economic situation arising, it has been agreed that the wage will be adjusted to meet new circumstances.

CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT Per bbl., carload lots, including 40c per bbl. for bags, cash discount not included			SAND AND GRAVEL Per ton, carload lots			CRUSHED STONE Per ton, carload lots		CRUSHED SLAG Per ton, carload lots, f.o.b. plant		CONCRETE Ready Mixed 1:2:4, 50 c.y. or more, delivered
	Cloth Bags*a*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.90	$2.65	....	$1.75	$1.85	$1.95	$1.65	$1.75	$1.55	$1.65	$7.90
Baltimore	2.31	2.06	1.86	1.75‡	1.75‡	1.25‡	1.75‡	1.75‡	1.75‡	1.75‡	6.50
Birmingham	2.50	2.25	2.05	1.80	1.80	1.50	1.00	1.00	.90	1.15	5.80
Boston	2.75*b*	2.50*b*	2.30	1.10‡	1.10‡	.80‡	1.10‡	1.10‡	....	....	6.75*m*
Chicago	2.60	2.35	2.20	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	1.25‡	1.25‡	....
Cincinnati	2.58	2.33	2.08	1.20	1.20	1.10	1.80	1.80	....	....	6.60
Cleveland	2.29	2.04	....	1.45*i*	1.45*i*	1.45*i*	1.70*i*	1.70*i*	1.70*i*	1.70*i*	6.85*i*
Dallas	2.30	2.05	1.85	2.00*p*	2.00*p*	1.50*p*	1.69*p*	1.84*p*	....	....	6.20
Denver	3.02	2.77	....	1.20	1.40	.90	....	....	....	....	7.25
Detroit	2.15	1.90	1.70	1.30	1.40	.81	1.45	1.45	1.14‡	1.14‡	6.50
Kansas City	2.56	2.31	2.16	1.85	2.30	1.00	1.91	1.91	....	....	7.90*n*
Los Angeles	2.82*b*	2.62*b*	....	1.00	1.00	1.00	1.00*f*	1.00*f*	....	....	5.85
Minneapolis	3.00	2.75	....	1.00*h*	1.00*h*	.25*h*	1.00*h*	1.00*h*	....	....	7.60*j*
Montreal	....	1.75*r*	1.60*r*	....	....	1.25‡	.85‡*c*	1.00‡*c*	....	....	7.60*l*
New Orleans	2.41	2.16	1.96	1.50	1.50	1.25	....	....	....	....	7.25
New York	2.60‡	2.35‡	....	1.40*de*	1.40*de*	.90*de*	1.65*de*	1.75*de*	....	....	7.25
Philadelphia	2.32	2.07	1.87	1.55‡	1.65‡	1.25‡	....	....	1.00	1.00	7.95*k*
Pittsburgh	2.44	2.19	1.99	1.80‡	1.80‡	2.10‡	2.25‡	2.25‡	1.50	1.50	8.75
St. Louis	2.55	2.30	....	1.50‡	1.50‡	1.25/1.50‡	.85*h*	.85*h*	.75*g*	.75*g*	7.50
San Francisco	2.72	2.52	2.20	1.36	1.36	1.36	1.46	1.46	....	....	7.63
Seattle	2.95*o*	2.70*o*	....	1.00*o*	1.00*o*	1.00*o*	2.00*o*	2.00*o*	....	....	7.50*o*

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* Plus municipal tax. *d* Per cu. yd. *e* Barge lots alongside docks *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days. *r* 10c. per bbl. off, cash 20 days.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice. Subject discount 10c. per bbl. 20 days in Montreal.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind	$1.70	$1.65	Ironton, Ohio	$1.60	$1.55	Richard City, Tenn	$1.80	$1.75
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind	1.70	1.65	Steelton, Minn	1.80	1.75
Hannibal, Mo	1.70	1.65	Norfolk, Va	1.65	1.60	Universal, Pa	1.65	1.60
Hudson, N. Y	1.75	1.70	Northampton, Pa	1.55	1.50	Waco, Tex. (5c. Tax inTex.)	1.75	1.70
Independence, Kans	1.70	1.65	North Birmingham, Ala	1.70	1.65	Montreal	1.55	1.55

PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS			PAVING ASPHALT Per ton, less than 80 penetration		ASPHALT BINDERS — FLUXES Per gal. 80–300 penetration		CUTBACK ASPHALT Per ton		ROAD OILS Per gal.	ASPHALT EMULSION (Quick-breaking) Per gal.	
	Granite per M. lots of 50,000 4x4x8 in.	Brick per M. 3x4x8½ in. carload lots	Wood per sq. yd. 3½ in. 16-lb. treat	Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Drums
Atlanta	$73.00	$39.35	$2.25	$16.60*e*	$22.83*e*	$0.0645*e*	$0.1165*e*	$0.0684*he*	$0.1207*h*	$0.0634*e*	$0.0644	$0.0684
Baltimore	145.00‡	44.00‡	2.75	14.00	20.00	.06	.09	.065*h*	.115*h*	......	......	.....
Birmingham	......	28.50*j*‡	......	19.20	25.20	.0797	.1097	.0834*h*	.1334*h*	......	......	.....
Boston	90.00	46.50	3.25	14.00	20.00	.06	.09	.065*h*	.115*h*	......	.09‡	.12‡
Chicago	145.00	50.00	1.80*d*	14.00	18.00	13.00*g*	17.00*g*	.055*h*	.10*h*	.035	.08	.12
Cincinnati	112.00	37.50	......	14.31	18.31	.10	......	18.00	......	.0525	.....	.08
Cleveland	110.00	37.50	2.80	15.25	20.50	.07	.08	.07*h*	.085*h*	.035	.08	.09
Dallas	......	30.00	......	13.25	20.30	.06	.103	15.00	24.80	.055	.05/.07	.07/.09
Denver	......	27.50	......	......	......	......	......	......	......	......	......	.....
Detroit	......	35.00	......	13.60*f*	18.00*f*	.0678	.108	13.60	18.00	.0545	.0518	.0924
Kansas City	......	44.00	......	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11	.15
Los Angeles	......	50.00	......	6.50*b*	15.00	6.50*bg*	15.00*bg*	5.50*b*	......	.0192	.0525	.1125
Minneapolis	......	......	1.90*d*	19.20	24.20	.10	.12	19.30	28.30	.056	......	.....
Montreal	75.00	......	3.62	14.60	21.25	.105	.1375	.101*h*	.121*h*	.07	.13	.16
New Orleans	......	......	......	14.00*a*	19.00*a*	.055	.085	.06*h*	.09*h*	......	.078	.....
New York	......	68.00	2.75	15.00	21.00	.06	.09	.065*h*	.115*h*	......	.07	.11
Philadelphia	120.00	42.50	2.84	14.00	19.00	.055	.08	.06*h*	.09*h*	.05	.06	.09
Pittsburgh	120.00	35.50	......	......	......	......	......	......	......	......	......	.....
St. Louip	110.00/121.00	37.00	......	14.00	19.00	14.00*g*	19.00*g*	.06*h*	.095*h*	.04	.09	.125
San Francisco	......	70.00	......	6.50	15.00	6.50*g*	15.00*g*	7.00	17.50	.025	.0475	.117
Seattle	......	60.00*c*	......	13.71	23.51	......	24.11*g*	10.11/11.11	23.61/24.61	8.36*g*	.0575*i*	.1308*i*

‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3½x4x8½ in. *d* 2½ in. 6 to 8-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican. *g* Per ton. *h* Per gallon. *i* F.o.b. Martinez. *j* 3x3⅝x8½ in.

(Continued on page 82)

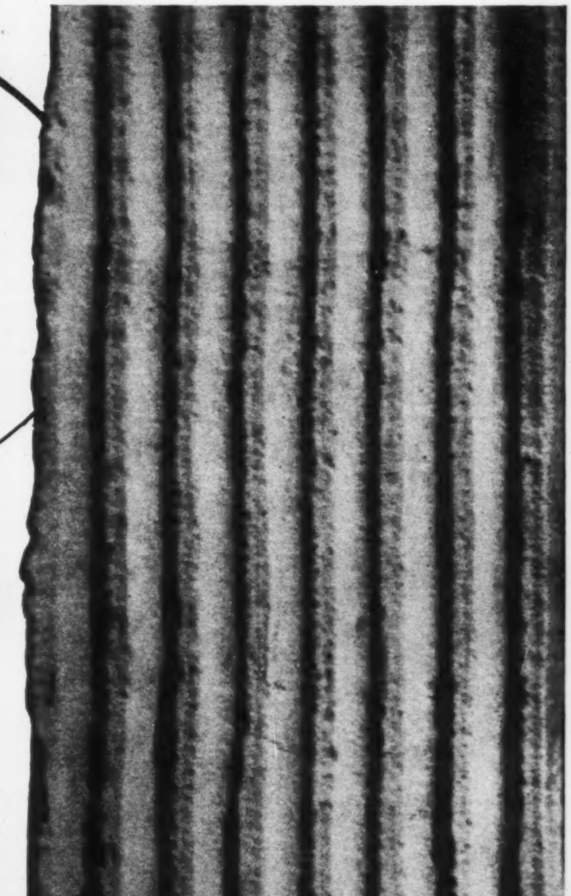
CONSTANT GAUGE HOLES

And why Timken Bits drill them . .

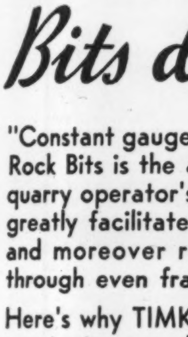
"Constant gauge holes" through the use of TIMKEN Rock Bits is the answer to every dimensional stone quarry operator's prayer. For constant gauge holes greatly facilitate subsequent broaching operations and moreover result in minimum loss of material through even fracture.

Here's why TIMKEN Removable Rock Bits can drill constant gauge holes *economically*. When the bit begins to get dull—it is removed and a sharp bit of identical gauge is attached to the same steel. Thus, it is necessary to carry only a small steel inventory whereas in the case of forged steel bits the inventory necessary to obtain constant gauge holes is prohibitive.

If you are in the dimensional quarry business and are not drilling constant gauge holes, why not let us demonstrate what TIMKEN Bits will do? Write us immediately. No charge, of course.



Sample of cores left by drilling constant gauge holes with TIMKEN Bits. Note cores same size from top to bottom thus facilitating broaching.



TIMKEN
ROCK BITS

Manufacturers of TIMKEN Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; TIMKEN Alloy Steels and Carbon and Alloy Seamless Tubing; and TIMKEN Rock Bits.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

(Continued from page 80)

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¾-in. billet *b*	RIVETS ¾-in. structural	WIRE NAILS Base *d*	SHEET PILING Base	STEEL RAILS Per Gross Ton Standard	Light	Re-rolled	TRACK SUPPLIES Angle Bars	Std. Spikes *c*	Tie Plates *c*	Track Bolts
Birmingham	$2.10	$2.15	$3.40	$2.55	....	$40.00	$40.00	$39.00	$2.70	$3.00	$2.15	$4.15
Chicago	2.10	2.15	3.40	2.55	$2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Pittsburgh	2.10	2.15	3.40	2.55	2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Buffalo	2.10	2.15	....	....	2.40	....	....	....	....	....	2.15	....
Cleveland	2.10	2.15	3.40	2.55	....	....	....	....	....	....	....	....
Youngstown	....	2.15	....	....	....	....	....	....	....	3.00	....	....
Detroit	....	2.25‡	....	....	....	....	....	....	....	....	....	....
Gulf ports	2.45*a*	2.50*a*	....	....	2.85*a*	....	....	....	....	....	....	....
Pacific ports	2.70*a*	2.60*a*	....	....	2.90*a*	....	....	....	....	3.00	2.25	....

‡ Delivered. *a* F.o.b. cars dock. *b* Rail steel same as billet prices. *c* Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates alone, Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. *d* Add switching charge $18 per c.l.

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB, BASE PRICE

	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS* Per 100 lb., ¾ in., base price 15 tons or over *b* New billet	Rail steel	Add Switch	$/cwt. for Del.	EXPANDED METAL LATH Per 100 sq.yd., carload lots Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING Per 100 s.f., carload lots 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in. No. 6 & 6 wires Per sq. yd.	SHEET PILING Per 100 lb. base price
Atlanta	$2.34	$2.39	$2.39	.02½	.10	$21.00	$23.00	$1.82	$1.35	$0.1719	$3.04
Baltimore	3.60	2.85	2.70	......	.10	21.00	23.00	1.70	1.27	.1611	2.75
Birmingham	2.10*a*	2.15	2.15	.02½	.10	19.50	21.50	1.80	1.34	.1701	....
Boston	3.85	2.73	2.58	$20 C.L.	.10	21.50	23.50	1.76	1.31	.1656	3.14
Chicago	2.10*a*	2.15	2.15	.03	.05	19.00	21.00	1.67	1.25	.1575	2.40
Cincinnati	3.68	2.51*c*	2.51*c*	......	.05	20.50	22.50	1.66	1.25	.1566	....
Cleveland	3.58*g*	2.15	2.15	.02½	.10	20.50	22.50	1.66	1.25	.1566	....
Dallas	4.75	3.25	3.25	......	......	25.00	27.00	1.93	1.42	.1827	....
Denver	4.35	3.95	3.80	......	......	23.50	25.50	1.97	1.45	.1863	....
Detroit	3.60‡	2.35	2.20	......	.10	22.50	24.50	1.68	1.26	.1584	2.66
Kansas City	4.03	2.51*c*	2.36*c*	.0	.05	18.50	20.50	1.78	1.33	.1683	2.86
Los Angeles	3.65*f*	2.65	2.50	.02½	.05	23.00	27.50	1.93	1.42	.1827	3.65
Minneapolis	3.80‡	2.48*c*	2.48*c*	.0	.10	21.50	24.50	1.80	1.34	.1701	2.73*d*
Montreal	3.80	2.65	2.55	......	......	26.00	28.60	2.99	2.08	.319	3.95
New Orleans	4.40	2.52	2.52	.05	.10	21.50	23.50	1.82	1.35	.1719	2.875
New York	3.75	2.39	2.39	......	.10	20.50	22.50	1.76	1.32	.1665	2.74
Philadelphia	3.55	2.66	2.56	......	......	19.50	21.50	1.71	1.28	.1611	2.72
Pittsburgh	2.10*a*	2.15	2.15	.02½	.10	21.50	24.50	1.59	1.20	.1503	2.40
St. Louis	3.47	2.39	2.39	.0	.05	24.00	28.00	1.69	1.27	.1602	2.70
San Francisco	3.35	2.525	2.375	.02½	.10	19.00	25.50	1.93	1.42	.1827	3.25
Seattle	2.70*e*	2.40*e*	......	......	......	25.50	27.50	1.93	1.42	.1827	2.90*e*

‡ Delivered. *a* Mill prices. *b* 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. *c* 20 tons or over Base. *d* Mill price plus freight. *e* F.o.b. dock. *f* Includes delivery in free delivery zone. *g* Less than 1 ton, add 30c.; 1 to 5 tons, add 10c. * High scrap steel prices cut former 15c. differences between new billet and rail steel in many mills.

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton f.o.b. 6 in. to 24 in. *a*	VITRIFIED SEWER PIPE Per foot, 8 in., s.s.	delivered 12 in., s.s.	ASTM 24 in., d.s.	C13–35 36 in., d.s.	CLAY DRAIN TILE Per 1,000 ft., carload lots, 6 in.	f.o.b. 8 in.	CONCRETE SEWER PIPE Per ft., delivered: ASTM 12 in.	C 14–35 24 in.	WROUGHT STEEL PIPE Full standard weight, *h* 1 to 3 in., Butt Weld Black %	Galv. %	3½ to 6 in., Lap Weld Black %	Galv. %
Atlanta	$49.40	$0.26*bc*	$0.468*bc*	$1.8525	$4.68*c*	$85.00	$128.00	$0.45	$1.625	62.2	54.2	59.7	51.2
Baltimore	52.80	.30	.55	2.30	6.80	110.00	150.00	.40	1.60	65.5	57.5	63.0	54.5
Birmingham	45.00	.26	.468	1.854	4.66	85.00	220.00	.40	1.60	62.2	54.2	59.7	51.2
Boston	55.00	.294	.567	2.16	6.15	199.00‡	288.00‡	.50	2.50	64.1	56.1	61.6	53.1
Chicago	53.80	.28	.54	2.25	6.25	100.00‡	150.00‡	.38	1.48	67.0	59.0	63.5	55.0
Cincinnati	52.70	.259	.4995	1.935	5.6375	75.00	120.00	.60	1.90	65.9	57.9	63.4	54.9
Cleveland	54.24	.21	.405	1.575	4.8175	69.00	108.00	.35	1.50	67.8	59.8	65.3	56.8
Dallas	58.20	.265	.477	1.728	4.70	80.00	100.00	.46	1.57	59.9	51.9	57.3	48.3
Denver	60.60	.24†	.52†	2.16†	......	130.00	240.00	......	......	58.4	50.4	55.7	47.2
Detroit	54.24	.147	.2835	1.215	4.70	66.45	111.40	1.62	1.125	66.3	58.3	63.8	55.3
Kansas City	55.12	.30	.54	2.16	5.00	120.00	240.00	.45	1.60	62.9	54.9	60.0	51.5
Los Angeles	55.00	.282†	.508†	2.034†	5.085†	115.50	192.50	1.00	2.00	56.8	47.8	54.3	44.8
Minneapolis	57.20	.24†	.432†	1.728†	4.60†	......	......	.70	1.80	64.2	56.2	60.7	52.2
Montreal	60.00	.55	.90	3.15	5.10*e*	135.00‡	260.00‡	.48	1.92	.....	......	......	......
New Orleans	51.38	.26	.48	1.69	......	150.00	220.00	.37	2.10	62.4	54.4	58.8	50.3
New York	52.20	.32	.63	2.52	6.45	......	......	.50	1.20	64.9	56.8	62.4	53.9
Philadelphia	50.90	.21	.405	1.75	5.05	100.00	160.00	.54	1.80	65.3	57.3	62.8	54.3
Pittsburgh	55.60	.245†	.4725†	1.845†	5.4325	97.80	154.20	.85*g*	2.00*g*	68.5*i*	60.5*i*	66.0*i*	57.5*i*
St. Louis	52.48	.24	.432	1.728	3.96	85.00	170.00	.75*j*	1.80*k*	65.1	57.1	62.0	53.5
San Francisco	55.00	.3275*d*	.5895*d*	2.358	5.895	107.25	178.75	.45	2.50	......	......	......	......
Seattle	55.35	.35	.63	2.52	6.30	72.00	175.00	.45*f*	1.40*f*	......	......	......	......

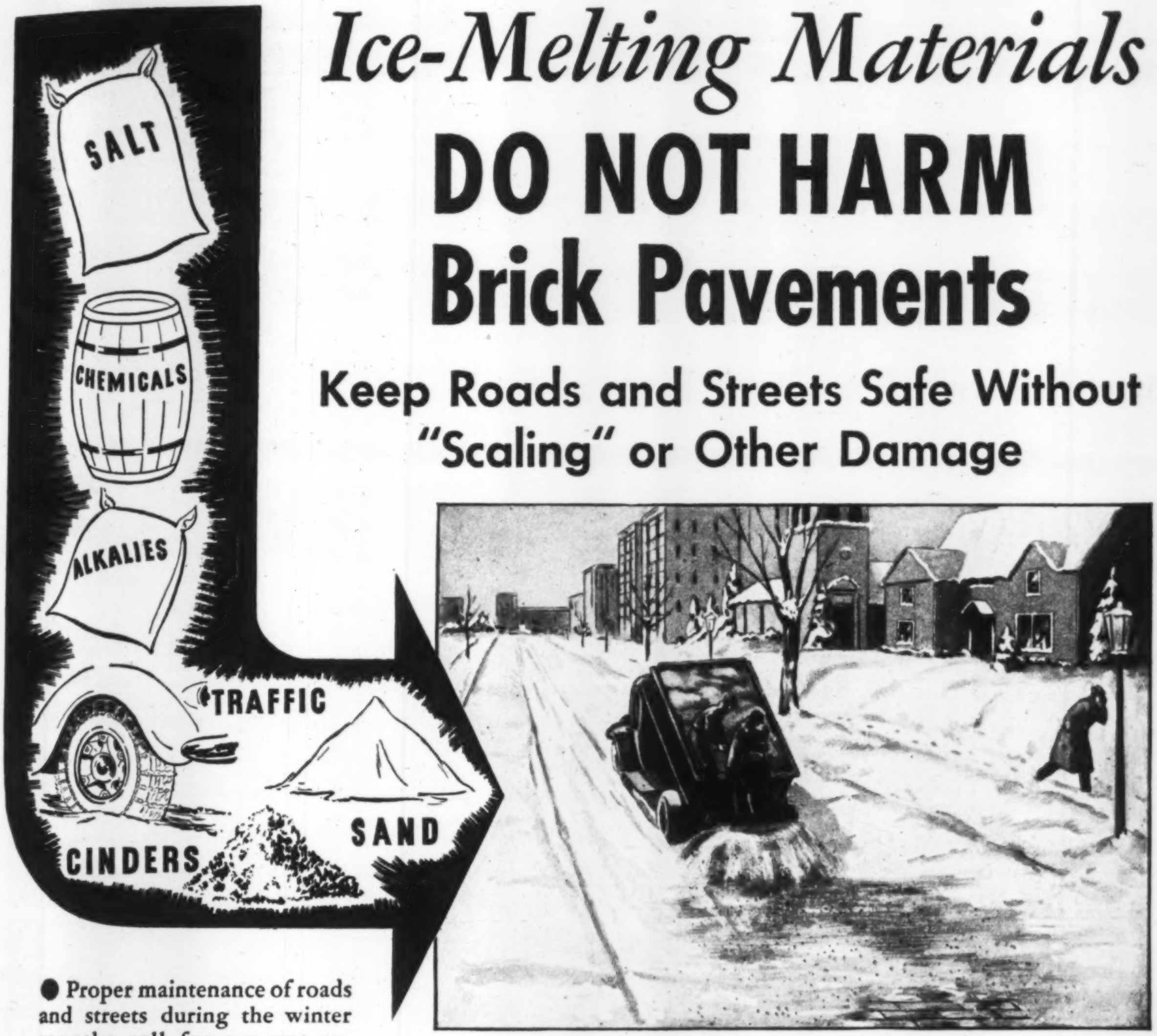
‡ Delivered. † F.o.b. *a* B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N. J. (base) $49.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. *b* Double strength. *c* List to dealer. *d* List. *e* 30-inch. *f* Less 5% for cash. *g* Culvert pipe. *h* Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ½ in., 8½c.; ¾ in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.: 3 in.. 76½c.: 4 in.. $1.09: 6 in., $1.92. *i* Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less on butt, 1½ on lap. Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld—1 in. and 1¼ in. black 34, galv. 19; 1½ in. black 38, galv. 21½; 2 in. black 37½, galv. 21. Lapweld—2½ in. to 3½ in. black 31½, galv. 17½ in.; 4½ in. to 8 in. black, 32½ galv. 20. *j* Reinforced; spec. C 76-37. *k* Reinforced; spec. C 75-37.

(Continued on page 84)

Ice-Melting Materials

DO NOT HARM Brick Pavements

Keep Roads and Streets Safe Without "Scaling" or Other Damage



● Proper maintenance of roads and streets during the winter months call for prompt removal of ice, if the accident rate is to be held within bounds.

The use of salts, chemicals and alkalies are cheap and convenient means of ice removal—wholly satisfactory except that they often cause scaling and deterioration of unsurfaced rigid pavements.

You can use any of these ice removal materials without damage to brick.

Nor is there damage to brick where these melting materials have been used as an admixture with sand or cinder stock piles.

And, of course, brick best withstands the concentrated chain-shod traffic in snow-rutted roads or streets. The experience record of hundreds of cities and other road building units and many accelerated tests have definitely established that point.

The cost of upkeep on brick pavements is always low, ranging from negligible to nil.

Brick resists damage from weather, traffic and ice-removal material, and thereby gives smooth, safe passage to any type of traffic at the lowest cost per year of service. National Paving Brick Association, National Press Building, Washington, D.C.

BRICK

FOR NEW CONSTRUCTION OR RESURFACE WORK

(Continued from page 82)

LUMBER, TIMBER, PLYWOOD—PER M FT. B.M., CARLOAD LOTS F.O.B.

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face) *All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)*									LONG LEAF Y. P. Merchantable grade up to 20 ft.		PLYWOOD Rail freight increment (See note for base price)	
	1x6,^{S4S}	1x8,^{S4S}	2x4,^{S4S}	2x6,^{S4S}	2x8,^{S4S}	2x10,^{S4S}	3x12,^{Rgh}	6x12,^{Rgh}	12x12,^{Rgh}	2x12,^{Rgh}	12x12,^{Rgh}	5/8"	3/4"
Atlanta	**$20.00**	**$20.00**	**$19.00**	**$20.00**	**$20.50**	**$22.00**	**$27.00**	......	......	$37.50	$50.50	$17.75	$21.60
Baltimore	**30.00**	**31.50**	**36.50**	**35.50**	**36.00**	**37.00**	**44.50**	......	......	67.00	68.00	17.35*g*	21.15*g*
	32.00	*32.00*	*34.00*	*33.00*	*34.00*	*34.00*	*44.50*	*$44.50*	*$40.00*	......	......	......	......
Birmingham	**22.50**	**23.50**	**22.00**	**21.00**	**22.00**	**23.00**	**37.00**	**36.00**	**36.00**	......	......	16.25	19.85
1	25.50	25.50	29.00	27.00	29.00	40.00	60.00	......	......	54.00	57.00	......	......
Boston	32.00^2	32.00^2	34.00^3	34.00	53.00^1	63.00^1	77.00^1	......	......	77.00	77.00	17.35*g*	21.15*g*
	29.00	*29.00*	*34.00*	*34.00*	*36.00*	*36.00*	*45.00*	*45.00*	*50.00*	......	......	......	......
Chicago	**33.00**	**33.00**	**34.00**	**34.00**	**34.00**	**34.00**	**50.00**	......	......	80.00	90.00	13.15	16.05
	37.00	*37.00*	*39.00*	*38.00*	*40.00*	*40.00*	*44.00*	*43.00*	*43.00*	......	......	......	......
Cincinnati	**31.50**	**33.00**	**30.50**	**31.00**	**32.00**	**35.00**	**44.50**	......	......	53.00	56.00	16.25	19.85
	......	......	......	......	......	......	*46.00*	*46.00*	*46.00*	......	......	......	......
Cleveland	**32.00**	**32.50**	**33.00**	**33.00**	**36.00**	**38.00**	**45.00**	46.00	46.00	80.00	80.00	16.65	20.25
Dallas *e*	**28.50**	**32.00**	**31.50**	**29.00**	**30.50**	**32.50**	**52 50**	**52.50**	**52.50**	63.50	71.00	13.90	16.95
Denver ‡	47.00^4	45.00^4	42.00^4	40.00^4	40.00^4	41.00^4	48.00^4	60.00^4	71.50^4	......	......	9.90	12.05
Detroit	**35.00**	**35.00**	**35.00**	**35.00**	**38.50**	**42.00**	**46.00**	......	......	43.50	58.00	16.25	19.85
	......	......	......	......	......	*46.00*	*47.00*	*54.00*	*54.00*	......	......	......	......
Kansas City	**29.00**	**31.00**	**30.00**	**28.50**	**29.00**	**31.00**	**35.00**	......	......	55.00	60.00	12.25	14.95
	29.00	*30.00*	*30.00*	*28.50*	*29.00*	*30.00*	*35.00*	*39.00*	*39.00*	......	......	......	......
Los Angeles *a*	*36.00*	*35.00*	*36.00*	*33.00*	*33.00*	*33.00*	*38.00*	*46.00*	*39.00*	......	......	9.35*gh*	11.35*gh*
Minneapolis ‡*b*	47.00^6	47.00^8	......	......	......	......	......	......	......	......	......	12.05	14.70
‡	*38.00*	*38.00*	*39.00*	*39.00*	*39.00*	*39.00*	*59.00*	*59.00*	*59.00*	......	......	......	......
Montreal ^{7}	*46.00*	*46.00*	*49.00*	*49.00*	49.00	58.00	85.00	......	......	155.00	165.00	......	......
	41.00	*41.00*	*40.00*	*40.00*	*40.00*	*42.00*	*42.00*	*40.00*	*40.00*	......	......	......	......
New Orleans	**24.00**	**25.00**	**25.00**	**24.00**	**24.00**	**25.00**	**46.00**	......	......	62.00	69.00	13.90	16.95
	29.00	*29.00*	*32.00*	*33.00*	*35.00*	*34.00*	*36.00*	......	......	......	......	......	......
New York ‡	**38.00**	**39.00**	**37.00**	**38.00**	**38.00**	**39 00**	**42.00**	......	......	80.00*f*	82.50*f*	17.35*g*	21.15*g*
‡	......	......	*45.00*	*45.00*	*45.00*	*45.00*	*45.00*	*47.50*	*47.50*	......	......	......	......
Philadelphia	**24.00**	**24.50**	**25.50**	**25.50**	**27.50**	**27.50**	**29.00**	......	......	50.00	57.50	17.35*g*	21.15*g*
	35.00	*36.50*	*39.00*	*38.25*	*39.00*	*39.00*	*44.00*	*32.00*	*32.00*	......	......	......	......
Pittsburgh	**38.10**	**39.90**	**47.05**	**42.00**	**45.65**	**46.90**	**59.70**	......	......	......	......	17.00	20.70
	51.90	*49.60*	*49.60*	*49.00*	*48.90*	*49.25*	*66.55*	*66.55*	*66.55*	......	......	......	......
St. Louis ‡*c*	**32.00**	**33.00**	**32.00**	**31.00**	**32.00**	**33.00**	**48.00**	*52.00*	*52.00*	73.00	72.00	13.90	16.95
San Francisco *d*	*22.50*	*23.00*	*23.00*	*22.50*	*22.00*	*22.50*	*23.50*	*23.50*	*23.50*	......	......	7.30*g*	8.90*g*
Seattle	*21.00*	*21.00*	*21.00*	*21.00*	*21.00*	*21.00*	*26.00*	*26.00*	*26.00*	......	......	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [6] Western Pine, No. 3 Common. [7] Pine. [8] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* At ship's tackle. *e* 10% discount taken off. *f* Up to 18 ft.

NOTE: Special concrete form grade Fir Plywood, 4′ by 8′ panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on 5/8", $77.00; on 3/4", $84.80; price includes oiling and sealing charges. For other centers add rail freight increment from table for proper size. For resin dipped treatment, add $10.00 per M. *g* Lower rate by water shipment. *h* 50,000 lb. minimum.

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS Discounts from jobbers list, Aug. 15, 1938 Single or Double Thickness A quality	 B quality	EXPLOSIVES Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots*
Atlanta	75%	75%	$0.15
Baltimore	83%	82%	.15
Birmingham	89%*d*	85%*d*	.105
Boston	82%	82%	.15
Chicago	79%	79%	.15
Cincinnati	79%	79%	.15
Cleveland	79-10-10%	79-10-10%	.19
Dallas	78%	78%	.165
Denver	76-10%	76-10%	.15*e*
Detroit	79-10%	79-10%	.15
Kansas City	79-10%	79-10%	.155
Los Angeles	86%*d*	88%*d*	.1575
Minneapolis	76%	76%	.155
Montreal	70-10%*ab*		.17†
New Orleans	70%	75%	.16
New York	82%	83%	.20*f*
Philadelphia	82-10%*d*	83-10%*d*	.15
Pittsburgh	79%	79%	.1425
St. Louis	79-10%	79-10%	.155
San Francisco	78%*d*	83%*d*	.155
Seattle	85%*d*	88%*d*	.1575

Price of 60% Ammonia Gelatin is $0.015 per lb. higher than 40%

a Disc. from list Sept. 1939. *b* Also less 6% tax exemption. *d* Discount from jobbers' list Sept. 15, 1928.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

	C/L 20,000 lb. net	Tons	200 lb. lots
E. of the Miss., except Fla.	$0.105	$0.14	$0.16
W. of Miss., to Rocky Mtn. States, and Fla.	.11 -.12	.135 -.15	.155 -.17
Rocky Mtn. States	.11 -.1325	.13 -.145**	.15 -.165**
Pacific N. W. States	.1075-.115	.1375-.15	.1575-.17
Pacific S. W. States	.1050-.1175	.135 -.1475	.155 -.1625

** F.o.b. Louviers, Colo., or Butte, Mont.

PILES, TIES—F.O.B.

PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf Barge	 Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.18	$0.195
12 in.— 2 ft. from butt	6 in.	50 to 59 ft.	.225	.24
12 in.— 2 ft. from butt	6 in.	60 to 69 ft.	.23	.255
14 in.— 2 ft. from butt	6 in.	50 to 69 ft.	.24	.265
14 in.— 2 ft. from butt	6 in.	70 to 79 ft.	.28	.275
14 in.— 2 ft. from butt	5 in.	80 to 85 ft.	.40	.415
14 in.— 2 ft. from butt	5 in.	85 to 89 ft.	.42	.482

RAILWAY TIES

Prices f.o.b., per tie for carload lots:		6" x8" x8′ Untr.	 Tr.	7" x 9" x8′6" Untr.	 Tr.
Boston	Oak	$1.20	....	$1.65	....
	Pine	1.50	$2.25*a*	2.25	$3.20*a*
New York	S. L. Sap Pine	1.10/1.20	1.85	1.50	2.35
	Mixed Oak	1.45	1.95	1.90	2.45
Birmingham	White Oak	.85	1.50*a*	1.35	1.70*a*
	Southern Pine	.55*b*	1.10*ab*	.70	1.30*a*
Chicago	Oak	....	1.65*a*	....	2.25*a*
	Southern Pine	....	1.53*a*	....	2.13*a*
Los Angeles	Douglas Fir	.64	1.38*a*	.90	1.80*a*
Philadelphia	Red Oak	1.10	....	....	2.40*a*
St. Louis	White Oak	1.12	....	1.50	....
	Red Oak	1.12	1.60*a*	1.50	2.03*a*
	Sap Pine or Cypress	1.02	....	1.40	....
San Francisco	Douglas Fir	.90*bef*	....	....	1.95*caf*
Montreal	Birch or Maple	.65	1.05*a*	.75	1.35*a*

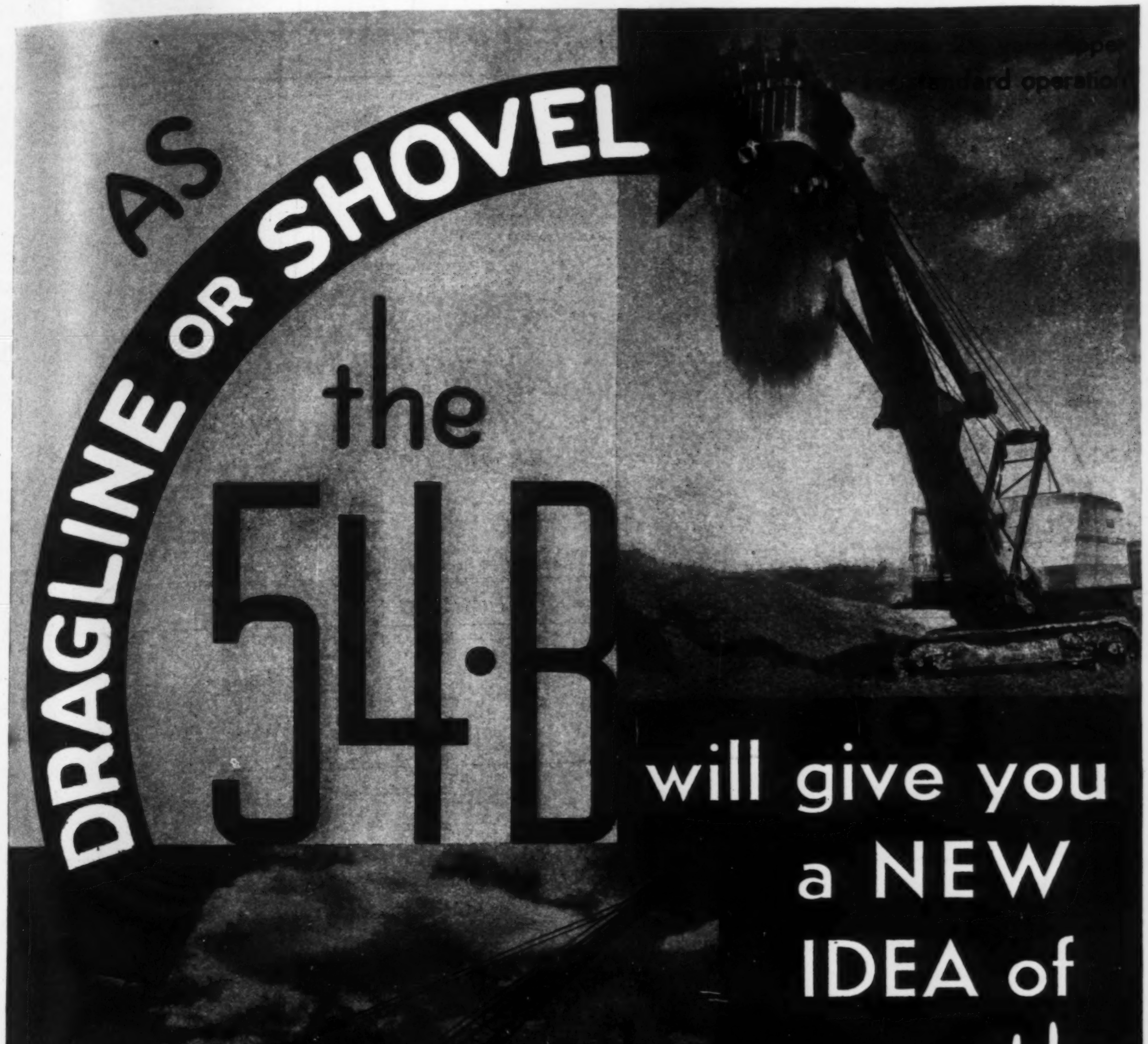
Tr.— Treated; Untr.— Untreated. *a* Creosoted. *b* 6" x 8" x 8′6". *c* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f.o.b. works, per 100-lb.	$2.00-2.85
Chlorine cylinders, liquid, per lb. delivered	.0525
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, delivered, per ton	22.00-35.00
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb.	1.40
Soda ash, 58%, in paper bags, per 100 lb. dense	1.10
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	23.00
Sulphate of copper, in bbl., per 100-lb.	4.75

(Continued on page 86)



[illegible]
[illegible] standard operation

AS DRAGLINE OR SHOVEL the 54-B will give you a NEW IDEA of *profitable* DIRT MOVING

FIND OUT ABOUT IT **NOW!**

Booms from 50 to 100 feet
Buckets from 3 to 1½ yards

Bucyrus·Erie
SOUTH MILWAUKEE, WISCONSIN

(Continued from page 84)

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE — PARTITION — SCORED Per M. lots of 2,000 pieces or over, 3x12x12 in.	4x12x12 in.	8x12x12 in.	STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M. lots of 2,000 pieces or over, 8x12x12 in.	10x12x12 in.	12x12x12 in.	BRICK Per M. in quantity. Common backing	Straight hard	LIME Per ton, Hydrated finishing	In paper Common hydrated	Carload lot Pulverized or lump
Atlanta	$90.00	$100.00	$185.00	$220.00	$230.00	$240.00	$12.50	$16.00	$26.50	$17.00	$17.00
Baltimore	74.00	80.00	165.00	190.00	240.00	290.00	13.00*k*	16.00*k*	18.50	14.50	2.50*m*
Birmingham	80.00	85.00	160.00	191.00	252.00	288.00	13.50	16.50	18.11	12.35	1.66*lo*
Boston	82.10*a*	87.60*a*	164.20*a*	186.10*a*	243.20*a*	277.90*a*	17.00*i*	20.00*i*	19.00	12.50	3.10*lp*
Chicago	68.10	72.60	135.90	185.70	234.90	268.10	11.00	12.00	16.40	14.40	12.20
Cincinnati	61.40	65.30	121.90	141.50	187.30	215.20	16.00	16.00	15.90	13.00	.....
Cleveland	56.50	60.00	112.50	135.00	182.50	209.50	16.00	16.00	15.00*j*	12.00*j*	2.75*jm*
Dallas	62.50	67.00	135.00	162.00	177.00	263.00	11.50*i*	13.50*i*	19.00	15.00	.95*n*
Denver	84.80	95.40	152.70	178.20	212.00	227.90	13.50	17.00	28.00*j*	17.00*j*	35.00*j*
Detroit	68.90	73.50	137.80	175.50	232.00	265.00*e*	15.70	17.00	13.50	11.75	12.75
Kansas City	64.50	66.50	86.00*c*	125.50	159.75	186.25	14.00	24.00	19.10	12.80	10.70
Los Angeles	73.50†*r*	89.50†*r*	128.00*c*†*r*	210.00†*r*	368.00†*r*	460.00†*r*	13.00	15.00	16.50	.....	17.50
Minneapolis	66.70	71.20	122.50	141.30	149.30	209.40	13.10	15.10*g*	21.00	16.00	19.00
Montreal	77.20*a*	77.50*a*	142.50*at*	76.00*a*	165.80*a*	248.70	20.75	28.00	23.50	17.00	11.00
New Orleans	72.00	72.00	135.00	162.00	210.00	260.00	14.00	.....	18.30	12.08	14.10
New York	87.00	93.00	128.00*c*	193.30*h*	238.80*h*	295.60*h*	14.50	.....	20.00	14.00	18.00
Philadelphia	80.50	85.90	161.10	193.30	238.80	296.60	15.00*s*	18.00*s*	15.50*q*	9.55*q*	12.05*q*
Pttsburgh	58.40	62.40	116.85	124.00	153.00	193.75	17.00	25.00	17.90	15.40	2.55*m*
St. Louis	62.00	88.00	120.00	180.00	234.00	280.00	16.00	17.00	22.00	18.00	2.30*lm*
San Francisco	84.00	94.50	225.00	......	......	......	14.00	17.00	.55*o*	.40*o*	2.05*m*
Seattle	100.00	110.00	220.00	......	......	......	17.50*f*	17.50*f*	20.00*s*	20.00*s*	20.00*s*

† F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6 x 12 x 12 in. *d* Not load bearing. *e* 48 lb. tile. *f* Less $1.00, ½ cash 15 days, balance 30 days. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* 50c per M. off for cash. *j* LCL. *k* $1.00 discount if paid in 10 days. *l* Lump. *m* Per bbl., 180 lb. *n* Per sack 100 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *q* 25-ton cars. *r* 5% discount 10 days. *s* 2% off cash. *t* 5½ x 8 x 12.

PAINT, ROOFING—F.O.B. CARLOAD LOTS

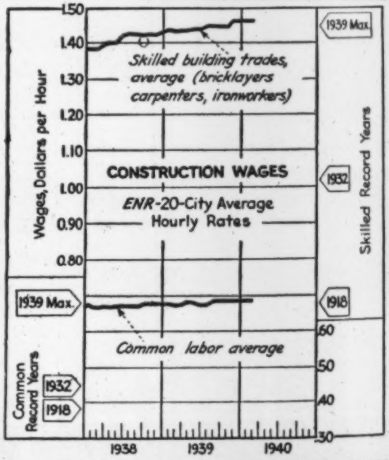
	RED LEAD Per 100 lb. in. 600-lb. (Approx.) bbl. Dry *a*	WHITE LEAD Per 100 lb. in oil	READY-MIXED PAINT Per gal., drums Graphite *b*	Aluminum *c*	Ferric Oxide *d*	ROOFING SUPPLIES Carload lots f.o.b. factory Rolls, slate surfaced, 85–90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch 350 lb. bbl. per ton
Atlanta	$9.25	$13.125	$1.30	$2.25	$1.20	$1.71	$1.65	$1.65	$0.36	$26.00
Baltimore	9.00	12.75	1.70	2.45	1.95	2.20	2.75	2.75	.45	27.50
Birmingham	9.25	13.125	2.68	2.75	1.85	1.92	1.77	1.77	.45	27.00
Boston	9.00	12.75	1.70‡	2.20‡	1.75‡	1.70‡	1.80*h*‡	1.80*h*‡	.45‡	20.00‡
Chicago	9.00	12.75	1.96	2.63	1.68	1.45*hf*	1.53*hf*	1.53*hf*	.26*f*	21.00*f*
Cincinnati	9.00	12.75	1.65	2.85	1.55	2.40	2.39*h*	2.39*h*	.36	21.00
Cleveland	9.00	12.75	1.90	2.60	1.60	1.68	1.55*h*	1.55*h*	.35	21.00
Dallas	9.00	13.50	1.88	2.11	....	2.75*h*	2.60*h*	2.70*h*	.275	34.00
Denver	9.50	13.25	1.65	2.40	.17*l*	2.45	4.00	3.00	.35	18.00
Detroit	9.00	12.75	2.00	3.00	1.75	2.40	2.75	2.75	.35	27.50
Kansas City	9.00	12.875	2.15*g*	2.40*g*	1.67*g*	1.93	2.09	2.09	.25	25.00
Los Angeles	9.25	13.25	1.60	2.25	2.30	2.10	1.50	....	.45	....
Minneapolis	9.00	12.875	....	....	....	1.68*i*	1.50*hi*	1.50*hi*	.29	21.00
Montreal	9.25	9.00	2.25	2.80	2.35	2.53	1.68	1.78	.70	1.68*k*
New York	9.00	12.75	1.88	2.55	1.60	1.68	1.45*h*	1.45*h*	.23	24.00
Philadelphia	9.00	12.75	....	....	....	1.92*e*	1.99*he*	1.99*he*	.41*e*	21.00
Pittsburgh	9.00	12.75	1.05	1.95	.80	1.95	1.94*h*	1.94*h*	.34	26.00
St. Louis	9.00	12.75	1.90/2.00	2.60/2.85	1.60/2.00	1.55	1.50	1.50	.235	21.00
San Francisco	9.25	13.00	1.80	2.75	1.10/2.00	1.66	1.90	1.90	.325	20.50
Seattle	9.25	13.25	1.80	2.60	....	1.81	1.30/2.00	1.75	.35	28.00*j*

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. *a* Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept. Spec. 3-49A. *c* ASTM Spec. D266-31. *d* 80% minimum ferric oxide. *e* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal can; *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Asphalt pitch. *k* per 100 lb. *l* per lb.

SKILLED AND COMMON WAGE RATES—PER HOUR

	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Heavy Const.
Atlanta	$1.25	$1.00	$1.375	$1.00/1.25	$1.25	$0.40/.50	$0.40/.50
Baltimore	1.50	1.25	1.65	1.50	1.25	.5625	.5625
Birmingham	1.50	1.125	1.25	1.125	1.00	.30/.40*a*	.30/.40*a*
Boston	1.50	1.375	1.50	1.625	1.625	.60/.85	.60/.85
Chicago	1.70	1.625	1.70	1.70	1.70	1.025	1.025
Cincinnati	1.625	1.45	1.525	1.00/1.525	1.625	.60/.75	.60/.75
Cleveland	1.625	1.375	1.50	1.50/1.75	1.50	.90	.90
Dallas	1.50	1.00	1.25	1.00	1.50	.40/.50	.40/.50
Denver	1.65*b*	1.50*b*	1.43*b*	....	1.50*b*	.718*b*	.718*b*
Detroit	1.50	1.25	1.50	1.50	1.55	.60/.75	.60/.75
Kansas City	1.625	1.375	1.50	1.50	1.575	.85	.50
Los Angeles	1.25	1.10	1.375	1.375	1.50	.625	.625
Minneapolis	1.375	1.25*d*	1.50	1.40	1.50*e*	.85	.85
New Orleans	1.50	1.20	1.50	1.50	1.40	.40	.40
New York	1.90*b*	1.75*b*	1.925	2.00*b*	2.00*e*	1.031	.875/.95
Philadelphia	1.65*b*	1.25	1.65	1.50	1.565	.60	.60
Pittsburgh	1.75	1.50	1.50	1.25	1.75	.80	.70
St. Louis	1.50	1.25/1.50	1.75	1.75/2.00	1.58/1.75	.45/.875	.45/.875
San Francisco	1.75*c*	1.25*f*	1.50	1.50	1.60*c*	.81	.65
Seattle	1.60*c*	1.25	1.50*c*	1.50*c*	1.60*c*	.90*c*	.90*c*
Montreal	.80	.70	.75	.65	.80	.45	.40

a PWA. *b* 7 hr. day. *c* 6 hr. day. *d* 35 hr. wk. *e* 30 hr. wk. *f* Working under "stop-gap" agreement.



ENR Skilled Average: (Bricklayers, Carpenters, Ironworkers) $1.465
ENR Common Average: $0.685